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Revision 0

Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area TX-TY

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

P.O. Box 550
Richland, Washington 99352

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J E Bratton 2/8/2011
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Executive Summary

Waste Management Area (WMA) TX-TY, which contains the TX and TY Tank Farms, is regulated under RCW 70.105[1] and the implementing requirements in WAC 173-303-400.[2] The Washington State Department of Ecology (Ecology) has been authorized by the U.S. Environmental Protection Agency, in accordance with *Authorized State Hazardous Waste Programs*,[3] to conduct its hazardous waste regulatory program in lieu of the *Resource Conservation and Recovery Act of 1976* (RCRA),[4] including the requirements in 40 CFR 265, Subpart F.[5] The WMA TX-TY is also subject to the requirements of the *Hanford Federal Facility Agreement and Consent Order*,[6] with Ecology identified as the lead regulatory agency for the unit.

The WMA TX-TY was placed in assessment monitoring in 1993 due to elevated specific conductance. A groundwater quality assessment plan was prepared in 1993 (WHC-SD-EN-AP-132)[7] describing the monitoring activities to determine whether WMA TX-TY had affected groundwater. The plan was updated in 2001 (PNNL-12072)[8] for continued RCRA groundwater quality assessment, as required by 40 CFR 265.93(d)(7).[9] The WMA TX-TY assessment plan was updated again in 2007 to include (1) information obtained from eight new wells installed at the WMA after 1999

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[1] RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington*, Olympia, Washington. Available at: http://apps.leg.wa.gov/RCW/default.aspx?cite=70.105.

[2] WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303-400.

[3] *Authorized State Hazardous Waste Programs*, 42 USC 6926, et seq. Available at: http://www.law.cornell.edu/uscode/42/6926.html.

[4] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://epw.senate.gov/rcra.pdf.

[5] 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring," *Code of Federal Regulations*. Available at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=fbf815e6fc70c4b56f27b33a7b919fb6&rgn=div6&view=text&node=40:25.0.1.1.6.6&idno=40.

[6] Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

[7] WHC-SD-EN-AP-132, 1993, *Interim-Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Areas T and TX-TY*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[8] PNNL-12072, 2001, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D1665266.

[9] 40 CFR 265.93, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Preparation, Evaluation, and Response," *Code of Federal Regulations*. Available at: http://edocket.access.gpo.gov/cfr_2010/julqtr/40cfr265.93.htm.

(PNNL-16005),[10] and (2) information from routine quarterly groundwater monitoring during the previous 5 years. This document supersedes the 2007 assessment plan to include significant events that have occurred at WMA TX-TY since that time and to update the groundwater monitoring project management organization description.

This plan describes the WMA TX-TY facility and operating history, waste characteristics, hydrogeology, previous monitoring at the WMA, groundwater and vadose zone contamination associated with the WMA and the conceptual model for the WMA. The plan also addresses the following:

- Number, locations, and attributes of wells in the WMA TX-TY groundwater monitoring network
- Sampling requirements and schedule for monitoring at WMA TX-TY
- Analytes, groundwater parameters, and analytical methods for dangerous wastes or dangerous waste constituents in the groundwater related to historical facility operations
- Procedures for evaluating groundwater quality data and information
- Reporting requirements

This assessment plan is the principal controlling document for conducting groundwater monitoring at WMA TX-TY.

[10] PNNL-16005, 2007, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-16005.pdf.

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Terms

amsl	above mean sea level
CAS	Chemical Abstracts Service
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CY	calendar year
DOE	U.S. Department of Energy
DQO	data quality objective
EBF	electromagnetic borehole flow meter
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FY	fiscal year
ID	identification
NA	not available
NAVD88	North American Vertical Datum of 1988
OU	operable unit
PFP	Plutonium Finishing Plant
PUREX	plutonium-uranium extraction
QAPjP	quality assurance project plan
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	reduction-oxidation
SST	single-shell tank
TCE	trichloroethylene
WMA	waste management area

1 Introduction

Waste Management Area (WMA) TX-TY, which contains the TX and TY Tank Farms, is located in the northern portion of the 200 West Area of the Hanford Site (Figure 1-1). The WMA was used for interim storage of radioactive waste from chemical processing of reactor fuel for plutonium production. The WMA is regulated under the *Resource Conservation and Recovery Act of 1976* (RCRA) and RCW 70.105 ("Hazardous Waste Management Act"), and its implementing requirements in Washington State dangerous waste regulations (WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards"). This plan implements the requirements of WAC 173-303-400(3), incorporating by reference 40 CFR 265 ("Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities"). The WMA TX-TY was placed in assessment monitoring in 1993 due to elevated specific conductance (a RCRA indicator parameter) in two downgradient wells. Assessment monitoring has continued at WMA TX-TY since that time due to the presence of chromium, a dangerous constituent. The objectives for the continued assessment of groundwater quality at WMA TX-TY, as required by 40 CFR 265.93(d)(7)(i) ("Preparation, Evaluation, and Response"), are to determine the following:

- Rate and extent of migration of the dangerous waste or dangerous waste constituents in the groundwater
- Concentration of dangerous waste or dangerous waste constituents in the groundwater

The scope of this plan is to obtain the necessary groundwater data to reach these objectives. The objectives are also related to the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) 200-ZP-1 Groundwater Operable Unit (OU) investigations and the vadose zone RCRA facility investigation/corrective measures study at WMA TX-TY. The integration of RCRA groundwater quality assessment with the 200-ZP-1 OU and the vadose zone RCRA facility investigation/corrective measures study requires consideration of certain nondangerous waste constituents and radionuclides, in addition to the dangerous waste constituents regulated under RCRA. Radionuclides are monitored under separate plans to support the objectives of CERCLA and the *Atomic Energy Act of 1954*.

This document is a revision of the previous groundwater assessment plan (PNNL-16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*) and includes significant events that have occurred at WMA TX-TY since the previous plan was issued. This monitoring plan is prepared to be consistent, to the extent possible, with the final status monitoring plan that will be incorporated into the *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8C, for the Treatment, Storage, and Disposal of Dangerous Waste* (WA7890008967) in the future.

Chapter 2 of this plan summarizes background information, with references to other documents for more detailed information. Chapter 2 also describes the WMA and the types of waste present, provides a brief history of groundwater monitoring, and describes geology and hydrology pertinent to WMA TX-TY. This information is summarized as a site conceptual model that aids in development of the groundwater monitoring program. Chapter 3 describes the RCRA groundwater monitoring program, including the wells in the monitoring network, constituents analyzed, sampling frequency, and sampling protocols. Chapter 4 describes data evaluation, interpretation, and reporting. A list of the references cited in this document is provided in Chapter 5. Appendix A provides the quality assurance project plan (QAPjP).

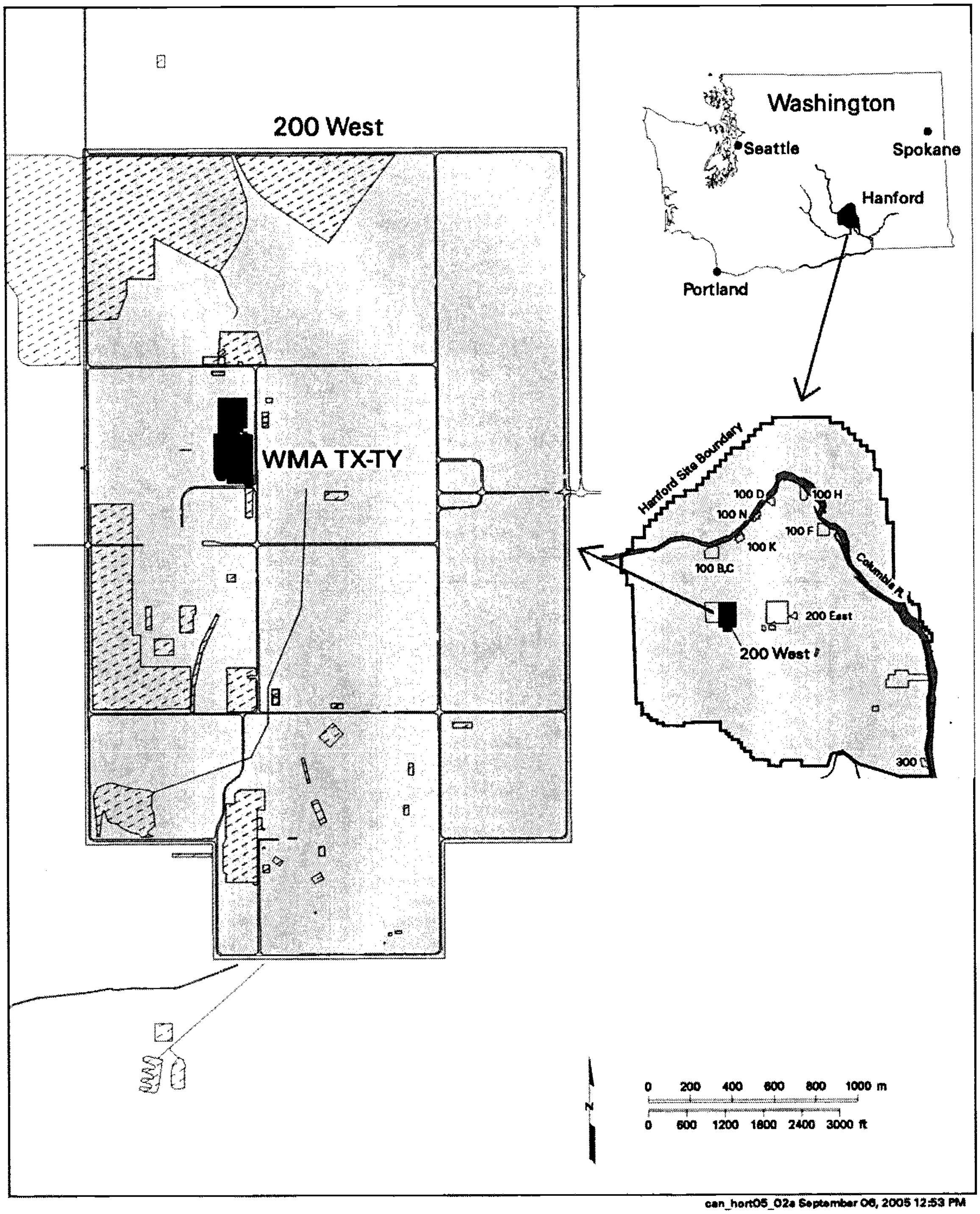


Figure 1-1. Location Map for WMA TX-TY

2 Background

This chapter describes WMA TX-TY facility and operating history. Discussion is also included on associated waste and waste characteristics at the WMA, local geology and hydrology, a summary of previous monitoring, groundwater and vadose zone contamination at the WMA, and a conceptual model.

The discussions in this chapter are summarized from previous documents, including the following:

- PNNL-11809, *Results of Phase I Groundwater Quality Assessment for Single-Shell Tank Waste Management Areas T and TX-TY at the Hanford Site*
- PNNL-12072, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY at the Hanford Site*
- PNNL-14099, *Groundwater Conditions at Single-Shell Tank Waste Management Area TX-TY (January 1998 Through December 2001)*
- PNNL-15837, *Data Package for Past and Current Groundwater Flow and Contamination Beneath Single-Shell Tank Waste Management Areas*
- PNNL-16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*
- RPP-23752, *Field Investigation Report for Waste Management Areas T and TX-Y*
- RPP-RPT-38320, *Surface Geophysical Exploration of the TX and TX Tank Farms at the Hanford Site*

2.1 Facility Description and Operating History

The WMA TX-TY is located in the northern portion of the 200 West Area (Figure 1-1). The WMA contains 24 underground single-shell tanks (SSTs), constructed in 1947 and 1948 for the TX Tank Farm and in 1951 and 1952 for the TY Tank Farm. Each tank has a capacity of 2.84 million L (750,000 gal). The 18 tanks in the TX Tank Farm are arranged in three 4-tank cascades and two 3-tank cascades. The six tanks in the TY Tank Farm are arranged in three 2-tank cascades. Tank cascades are sets of tanks that were constructed with elevation differences between tanks, which allow gravity-driven flow (cascading) of the waste stream from one tank to another. This allowed cooling and precipitation of radionuclides and solids to occur in each tank of the cascade. Some of the supernatant from the last tank in the cascade was sent to cribs via surface pipelines because of a shortage in tank storage capacity. As a result, it is difficult to estimate the composition of the waste remaining in the tanks based on operational records. In addition to the tanks, six diversion boxes and ancillary pumps, valves, and pipes are included in the Dangerous Waste Permit Application Part A form (WA7890008967) for the SSTs in the TX-TY Tank Farms system.

The tanks in WMA TX-TY began receiving waste in 1949. The tanks in both the TX and TY Tank Farms were used to support the bismuth phosphate process and the uranium-recovery program. Some of the tanks in WMA TX-TY also received waste from Reduction-Oxidation (REDOX) Plant and Plutonium-Uranium Extraction (PUREX) Plant operations.

Waste management operations have created a complex intermingling of tank wastes. Nonradioactive chemicals have been added to the tanks, and varying amounts of waste and heat-producing radionuclides have been removed. In addition, natural processes have caused settling, stratification, and segregation of waste components. A detailed history of tank farm operations is provided in *A History of the 200 Area Tank Farms* (WHC-MR-0132).

The pumpable liquid has been removed from all of the SSTs in WMA TX-TY, and all tanks have been interim stabilized. Each tank currently contains less than 189,250 L (50,000 gal) of drainable interstitial liquid and less than 18,925 L (5,000 gal) of supernatant liquid (HNF-EP-0182, *Waste Tank Summary Report for Month Ending September 30, 2004*, Rev. 198).

Initial corrective actions have been implemented at WMA TX-TY. Berms were constructed around the TX and TY Tank Farms in 2001 to stop run-on of natural precipitation, and all known water lines leading to the tank farms were cut and capped at that time. Additionally, an interim barrier over the TY Tank Farm was being constructed and expected to be completed in 2010. An interim measures maintenance plan consisting of annual inspections of drywell covers and visual inspections of run-off collection areas and culverts is in place and documented in the *Interim Measures Maintenance Plan* (WRPS-0900388).

HNF-EP-0182 assumed that 13 of the tanks in WMA TX-TY have leaked based on liquid losses; however, little information and no previous leak inventory estimates are available for seven of the tanks (RPP-23405, *Tank Farm Vadose zone Contamination Volume Estimates*). It must be noted that spectral gamma logging in drywells is only used to interrogate to a radius of 30.5 cm (12 in.) and, therefore, depends on the placement of the initial borehole. Contamination associated with the latter seven tanks may be the result of waste pipeline leaks or nearby tanks that are known to have leaked. The tanks with the three largest confirmed leaks from WMA TX-TY are TY-103, TY-105, and TY-106 (RPP-23405, *Tank Farm Vadose Zone Contamination Volume Estimates*).

In 2010, the *Hanford TY-Farm Leak Assessments Report* (RPP-RPT-42296) revised some of the leak estimates from HNF-EP-0182. For instance, RPP-RPT-42296 states that tank TY-101, which was previously identified as a leaker, is not actually a leaker based on the new methodology that shows the liquid level decreases were within the margin of error of equipment. In addition to leaks, 11 unplanned releases have been documented in the area of WMA TX-TY. The unplanned releases are described in the *T Plant Source Aggregate Area Management Study Report* (DOE/RL-91-61) and PNNL-16005.

2.2 Regulatory Basis

In May 1987, the U.S. Department of Energy (DOE) issued a final rule (10 CFR 962, "Byproduct Material") stating that the dangerous waste components of mixed waste are subject to RCRA regulations. In November 1987, the U.S. Environmental Protection Agency (EPA) authorized the Washington State Department of Ecology (Ecology) to regulate these dangerous waste components within the State of Washington (51 FR 24504, "EPA Clarification of Regulatory Authority Over Radioactive Mixed Waste"). In 1996, the Washington State Attorney General determined that the effective date of mixed waste in Washington State was August 19, 1987.

Groundwater monitoring is conducted at WMA TX-TY in accordance with 40 CFR 265, Subpart F ("Ground-Water Monitoring") and by reference of WAC 173-303-400(3). An indicator evaluation RCRA groundwater monitoring program for WMA TX-TY was initiated in 1989 (WHC-SD-EN-AP-012, *Interim-Status Groundwater Monitoring Plan for the Single-Shell Tanks* [Rev. 0, followed by Rev. 1 in 1991]). The WMA was placed into assessment monitoring in 1993 because specific conductance values in downgradient wells 299-W10-17 and 299-W14-12 exceeded the upgradient background (critical mean) value (WHC-SD-EN-AP-132, *Interim-Status Groundwater Quality Assessment Plan for the Single-Shell Waste Management Areas T and TX-TY*). The first assessment report (PNNL-11809) concluded the following: (1) elevated contamination in well 299-W14-12 was consistent with a source within the WMA, and (2) an upgradient source (216-T-25 Trench) was possible. Subsequent drilling and sampling of well 299-W15-40 (located between the 216-T-25 Trench and the WMA) eliminated the 216-T-25 Trench as a possible source of contamination downgradient of the WMA. The second assessment report, *RCRA Groundwater Quality Assessment Report for Single-Shell Tank Waste Management Area TX-TY (January 1998 Through December 2001)* (PNNL-14004), was not able to eliminate the WMA TX-TY as a source for the downgradient contamination. The presence of chromium, a dangerous constituent in groundwater, requires continued groundwater assessment. Accordingly, continued groundwater assessment is required, and this plan describes the activities for continued assessment.

2.3 Waste Characteristics

Two basic chemical-processing operations were the source of most of the dangerous waste transferred to the TX and TY Tank Farms: the bismuth phosphate process and the tributyl phosphate process. Lesser quantities of waste from the REDOX and PUREX processes were also sent to the tank farms. The bismuth phosphate, REDOX, and PUREX processes were chemical separations programs used to recover plutonium from irradiated reactor fuels. The tributyl phosphate process recovered uranium metal in waste generated by the bismuth phosphate process. Waste from these processes was made alkaline for storage in the tanks (WHC-MR-0132). WHC-MR-0132 provides approximate chemical compositions for the major waste types sent to the SSTs in the TX and TY Tank Farms, and *Hanford Soil Inventory Model, Rev. 1* (RPP-26744) provides detailed estimates for chemical and radioisotope concentrations in each tank leak in the WMA.

Table 2-1 lists the dangerous wastes specified in the Dangerous Waste Permit Application Part A form (WA7890008967).

Table 2-1. Dangerous Wastes in the Single-Shell Tank System (Dangerous Waste Permit Application Part A Form)

Dangerous Waste Code	Contaminant Description	Dangerous Waste Code	Contaminant Description
D001	Ignitable waste	D030	2,4-Dinitrotoluene
D002	Corrosive waste	D033	Hexachlorobutadiene
D003	Reactive waste	D034	Hexachloroethane
D004	Arsenic	D035	Methyl ethyl ketone
D005	Barium	D036	Nitrobenzene
D006	Cadmium	D040	Trichloroethylene (TCE)
D007	Chromium	D041	2,4,5-Trichlorophenol
D008	Lead	D043	Vinyl chloride
D009	Mercury	F001	1,1,1-Trichloroethane
D010	Selenium	F002	Methylene chloride
D011	Silver	F003	Acetone, methyl isobutyl ketone
D018	Benzene	F004	Cresol-m, -o, -p
D019	Carbon tetrachloride	F005	Methyl ethyl ketone

Table 2-1. Dangerous Wastes in the Single-Shell Tank System (Dangerous Waste Permit Application Part A Form)

Dangerous Waste Code	Contaminant Description	Dangerous Waste Code	Contaminant Description
D022	Chloroform	WP01	Extremely hazardous waste/ persistent dangerous waste
D028	1,2-Dichloroethane	WP02	Dangerous waste/ persistent dangerous waste
D038	Pyridine	WT01	Extremely hazardous waste/ toxic dangerous waste
D029	1,1-Dichloroethylene	WT02	Dangerous waste/toxic dangerous waste
D039	Tetrachloroethylene		

Notes:

1. This table is based on the Dangerous Waste Permit Application Part A form (WA789000896).
2. Analytes associated with the "F001" through "F005" waste codes are from WHC-MR-0517, *Listed Waste History at Hanford Facility TSD Units.*

2.4 Geology and Hydrogeology

This section describes of the geology and hydrology beneath WMA TX-TY. The geology specific to WMA TX-TY was first described in *Geology of the 241-TX Tank Farm* (ARH-LD-136) and *Geology of the 241-TY Tank Farm* (ARH-LD-137), and later in WHC-SD-EN-AP-012. More recently, the WMA TX-TY geology has been summarized in the following:

- HNF-2603, *A Summary and Evaluation of Hanford Site Tank Farm Subsurface Contamination*
- RPP-7123, *Subsurface Conditions Description of the T and TX-TY Waste Management Areas*
- RPP-23748, *Geology, Hydrogeology, Geochemistry, and Mineralogy Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site*
- PNNL-15955, *Geology Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site*
- PNNL-16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*

Updated information on the geology and hydrogeology at WMA TX-TY, including the most recent observations from new wells, is included in PNNL-15837.

The vadose zone beneath WMA TX-TY is between approximately 66 and 70 m (216 and 229 ft) thick and consists of the Hanford formation, the Cold Creek unit, the Taylor Flat member of the Ringold Formation, and the upper portion of Unit E of the Wooded Island member of the Ringold Formation. The water table is at approximately 134.5 m (441 ft) elevation based on fiscal year (FY) 2009 water table elevations. The unconfined aquifer beneath WMA TX-TY is estimated to be between 48.5 and 56.5 m (159 to 185 ft) thick based on water levels and the depth of the Ringold Formation lower mud unit, which serves as a confining or semiconfining layer separating the unconfined aquifer from a confined (or partly confined) aquifer in the underlying Ringold Formation Unit A.

Figure 2-1 shows a generalized hydrostratigraphic column for the Hanford Site. The geology beneath WMA TX-TY consists of a basalt basement overlain by nine sedimentary sequences, which are distinguished mainly by texture (particle size), mineralogy, responses to natural gamma logs, and stratigraphic position.

Water levels in the unconfined aquifer increased as much as 14 m (46 ft) above the pre-Hanford natural water table beneath WMA TX-TY due to artificial recharge from liquid waste disposal operations active between the mid-1940s and 1995. During that time, the groundwater flow direction changed from eastward (the pre-Hanford direction) to southward, then northward, and finally back toward the east as a result of changes in waste management practices. Groundwater levels continue to decline due to cessation of artificial recharge from liquid waste disposal operations in the area (Figure 2-2).

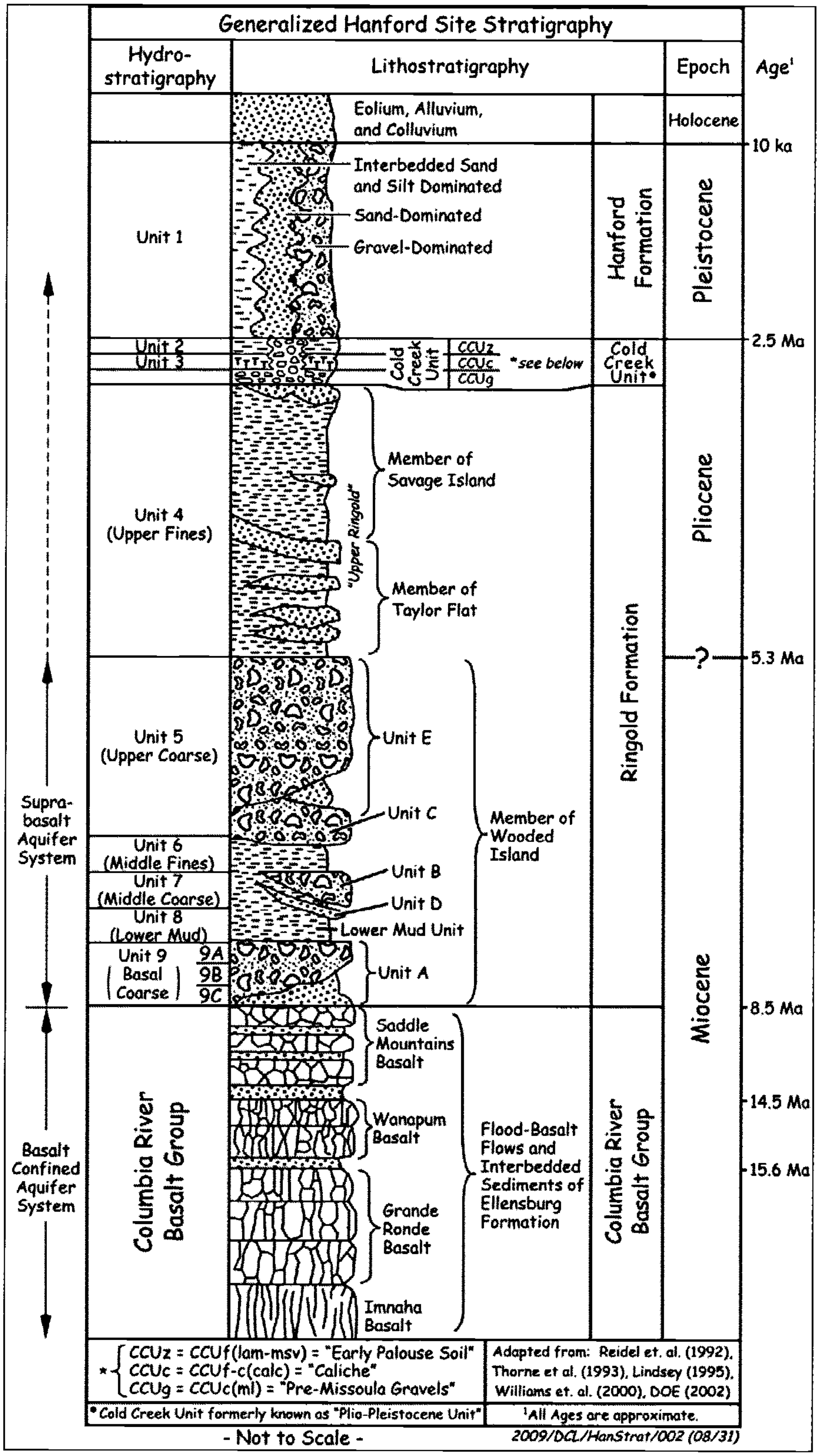
More recently, extraction wells for the 200-ZP-1 OU pump-and-treat system have altered the flow direction. In 2005, upgradient wells were converted to extraction wells, shifting the flow southward in the southern portion of the WMA and likely shifting flow toward the northwest in the northern portion of the WMA. Possible stagnation points exist in the middle portion of the WMA east of the extraction wells, and some flow is currently eastward in the middle of the WMA. Therefore, it must be assumed that the water table gradient is variable beneath WMA TX-TY due to influences from pump-and-treat system extraction wells. The large shifts in groundwater flow direction have large implications for contaminant distribution in the uppermost aquifer beneath WMA TX-TY. A current groundwater map for WMA TX-TY is provided in Figure 2-3.

Aquifer tests have been performed on new wells at WMA TX-TY since 1999. The details of the tests, data analysis, and test results are provided in the following:

- PNNL-13378, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 1999*
- PNNL-13514, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2000*
- PNNL-14113, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2001*
- PNNL-14186, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2002*
- PNNL-17348, *Results of Detailed Hydrologic Characterization Tests – Fiscal and Calendar Year 2005*
- PNNL-18279, *Aquifer Testing Recommendations for Well 299-W15-225: Supporting Phase 1 of the 200-ZP-1 Groundwater Operable Unit Remedial Design*

The salient results are listed below using the pertinent historical or latest compiled data from the above-listed documents:

- Hydraulic conductivities range between about 0.07 and 19.9 m/d (0.23 and 65.3 ft/d), with a geometric mean of 2.20 m/d (7.22 ft/d).
- Vertical heterogeneities in hydraulic conductivity exist among wells and within individual well screens.



Note: The member of Savage Island, the member of Wooded Island units C, B, and D, and the Snipes Mountain conglomerate are not present at WMA TX-TY.

Figure 2-1. Generalized Stratigraphy of the Hanford Site

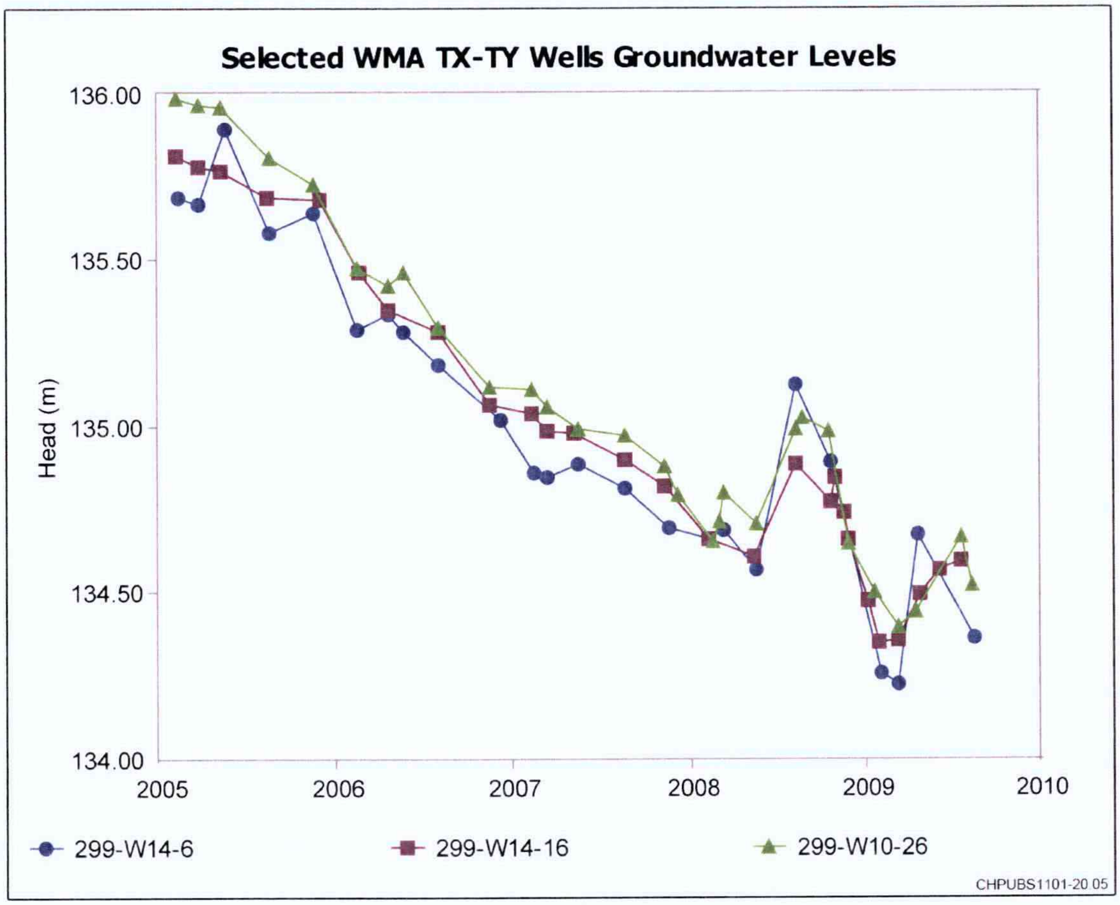


Figure 2-2. Selected Monitoring Wells Showing Groundwater Level Declines in WMA TX-TY

- The in-well, upward, vertical groundwater flow conditions were measured in 2005 within monitoring well 299-W14-11, which has a screened interval of 3 m (10 ft) and is located approximately 14 m (46 ft) below the water table. Vertical flow was measured in the borehole using electromagnetic borehole flow meter (EBF) surveys. Maximum vertical flow velocity recorded by the EBF was 0.014 to 0.027 m/m.
- In-well, downward vertical groundwater flow conditions were measured in well 299-W14-13 in 1999 and 2000 using vertical-flow tracer tests and EBF surveys. This well is screened across the water table, and the bottom of the screened interval is currently approximately 7 m (23 ft) below the water table. Well 299-W14-13 is located 6 m (19 ft) south of well 299-W14-11. Average vertical downward flow velocities were 0.011 to 0.012 m/m and were reproducible over a 9-month period during testing.

It is important to note that the existence of vertical flow is not necessarily reflective of the actual groundwater flow conditions within the surrounding aquifer. However, the presence of vertical flow implies a vertical flow gradient and has implications pertaining to the representativeness of groundwater samples collected from such monitoring wells near the WMA.

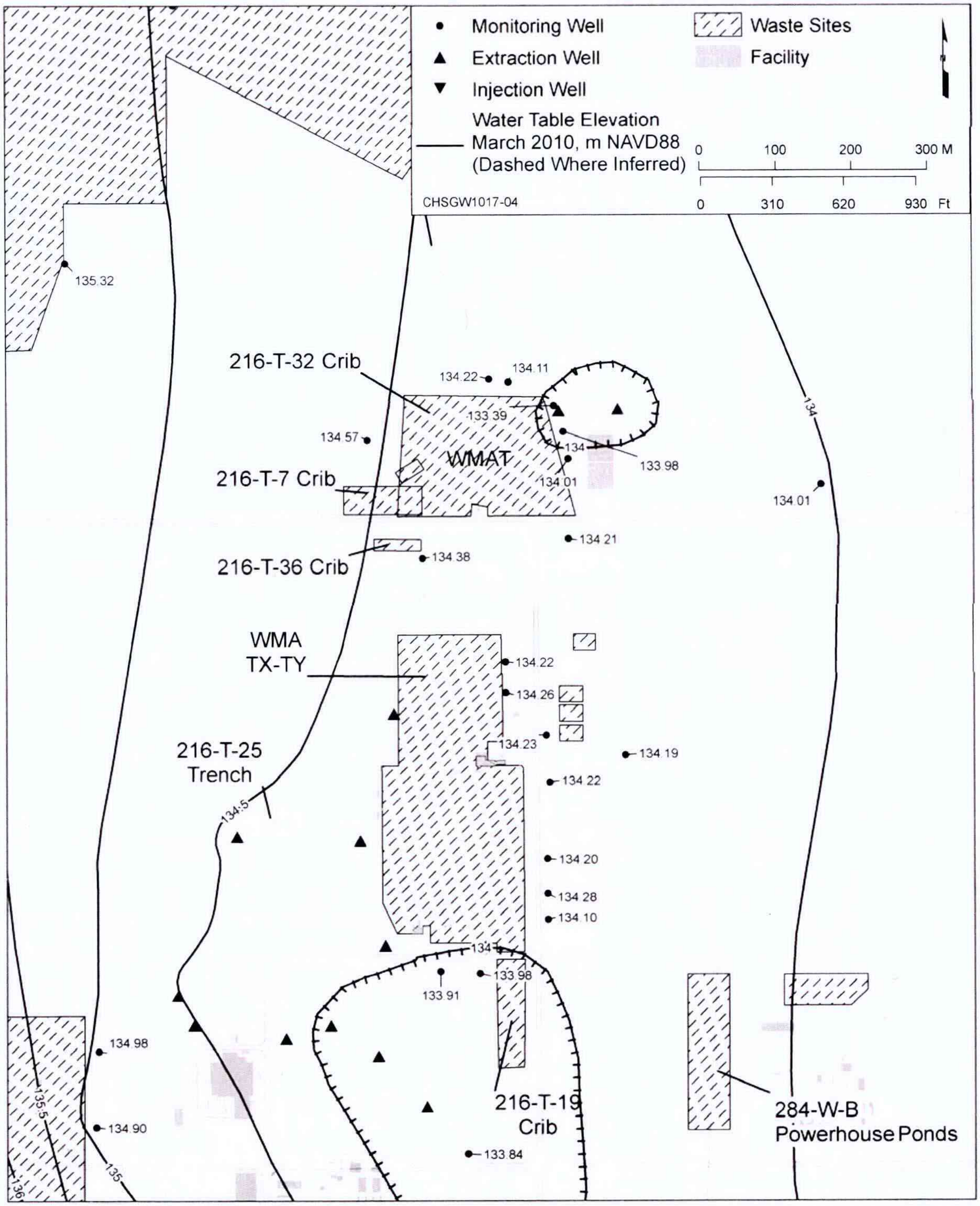


Figure 2-3. Water Table Map for Area Around WMA TX-TY, March 2010

2.5 Summary of Previous Groundwater Monitoring

This section summarizes the current and historical groundwater contamination at WMA TX-TY. The vadose zone contamination is also summarized because any residual vadose zone contamination is a potential source for future groundwater contamination.

2.5.1 Groundwater Contamination

Chromium is the sole RCRA dangerous constituent found beneath WMA TX-TY, with an associated source in the WMA. Carbon tetrachloride and trichloroethylene (TCE) are also present, but the source of these constituents was liquid disposal associated with processes at the Plutonium Finishing Plant (PFP) and not WMA TX-TY. These constituents are monitored as part of the 200-ZP-1 Groundwater OU. Nitrate is also found in the groundwater beneath the WMA. Plume maps for all of these constituents are provided in *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volumes 1 & 2* (DOE/RL-2010-11).

2.5.1.1 Chromium

Chromium concentrations exceeded the drinking water standard (100 µg/L) in two wells during routine sampling at WMA TX-TY during 2009. The highest chromium concentrations have historically been in well 299-W14-13, screened at the water table and located downgradient of the WMA. This well is located between nearby past-practice liquid disposal designated waste sites (216-TX/TY Cribs and 241-153-TX diversion box unplanned release). The concentration in January 2009 was 744 µg/L; by October 2009, the concentration in this well was 397 µg/L. The chromium concentration in adjacent well 299-W14-11, screened 11.6 to 14.6 m (38.1 to 47.9 ft) below the water table, was 194 µg/L in October 2009. The chromium concentrations in these two wells suggest that the highest concentrations occur near the water table in this area. Concentrations have historically fluctuated in the two wells and were exhibiting a decreasing trend at the end of calendar year (CY) 2009.

2.5.1.2 Nitrate

The WMA TX-TY lies within the regional 200 West Area nitrate plume. Nitrate exceeds the drinking water standard of 45 mg/L in all wells at the WMA. Most of the nitrate beneath the WMA is believed to have resulted from disposal to past-practice liquid disposal facilities in the area, although some contribution from WMA TX-TY is possible.

The highest nitrate concentration during 2009 was in well 299-W10-27, located at the northern portion of the downgradient side of the WMA. Nitrate concentrations began increasing rapidly in this well beginning in 2006 and peaked in 2007. Nitrate concentrations were exhibiting an overall gradual decreasing trend in this well during CY 2009, ranging from a high of 677 mg/L to a low of 452 mg/L near the end of the year. The 2009 annual average concentration for the well was 521 mg/L, which is a slight increase from the previous year's average.

2.5.2 Vadose Zone Contamination

Geophysical logging of drywells adjacent to SSTs in the TX and TY Tank Farms has delineated the extent of gamma-emitting vadose zone contamination, as presented in the following reports:

- GJO-97-13-TAR, *Hanford Tank Farms Vadose Zone – TX Tank Farm Report*
- GJO-97-13-TARA, *Hanford Tank Farms Vadose Zone – Addendum to the TX Tank Farm Report*
- GJO-97-30-TAR, *Hanford Tank Farms Vadose Zone – TY Tank Farm Report*
- GJO-97-30-TARA, *Hanford Tank Farms Vadose Zone – Addendum to the TY Tank Farm Report*

The maximum depth of vadose zone contamination is not known because the contamination extends deeper than the deepest vadose zone wells in the tank farms, as determined by sampling results obtained during drilling of the vadose zone wells.

More recently, a geophysical investigation at the WMA TX-TY (RPP-RPT-38320) used a well-to-well, long electrode resistivity measurement method. The well-to-well measurements were made using 105 steel-cased vadose zone wells, 30 groundwater wells, and 27 point electrodes. This study further defined the distribution of low-resistivity anomalies associated with the specific retention trenches and cribs, as well as along the pipelines that cross the WMA. The distribution of low-resistivity anomalies that are usually related to tank-process contamination should be of particular interest in regard to assessment and remediation of the WMA and associated facilities.

Figures 2-4 and 2-5 show geophysical anomalies detected during surface geophysical characterization performed at WMA TX-TY during FY 2008. The objective of the investigation was to collect and analyze electrical resistivity data in order to identify and locate discrete, low-resistivity regions in the subsurface to guide future sampling and analysis efforts. The figures show the results from the well-to-well, long electrode electrical resistivity measurement method. Tanks assumed to have leaked are colored differently in the figures for reference.

An in-depth summary and discussion of the investigation results is presented in RPP-RPT-38320. A brief description of the investigation findings is provided below:

- For the TY Tank Farm, the resistivity inversion model results indicate several low-resistivity targets, which are located in close proximity to underground storage tanks that are assumed to have leaked.
  - In contrast, no significant low-resistivity targets were located near tank TY-102, which is not known to have leaked.
  - The well-to-well results suggest that infrastructure within the TY Tank Farm does not control the distribution of low-resistivity targets found in association with the tanks that are assumed to have leaked.
- For the TX Tank Farm, the resistivity inversion model results within the tank farm show more dispersed low-resistivity targets, which are in some cases linear-shaped along locations of known pipelines.
  - The shape and position of the low-resistivity targets with respect to known infrastructure suggest that the numerous pipelines may be influencing the size, shape, and locations of the low-resistivity targets within the TX Tank Farm.
  - Although the more numerous buried infrastructure may be affecting the low-resistivity targets when compared to the TY Tank Farm results, a clustering of low-resistivity targets exist around tanks 107, 108, 111, and 112.

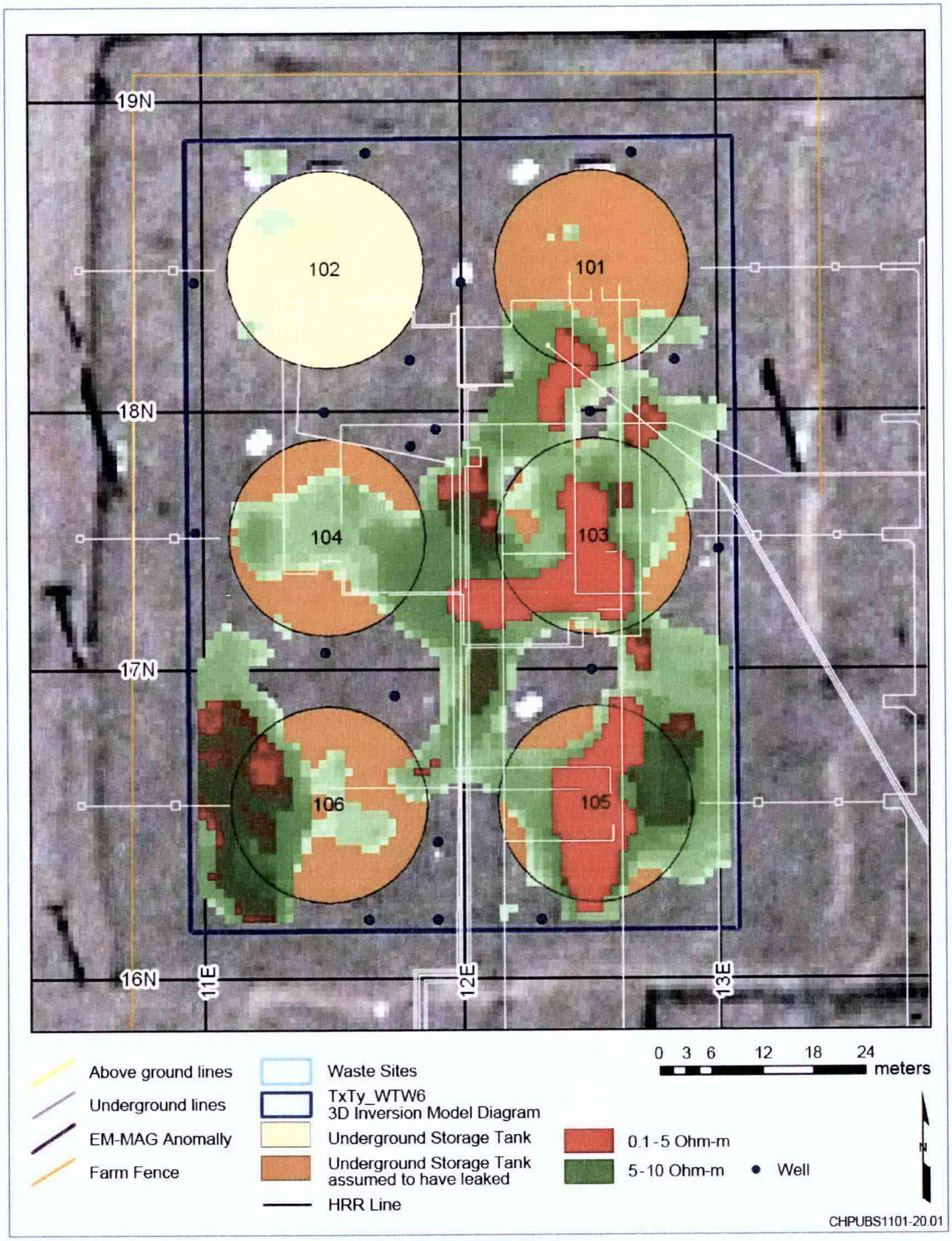


Figure 2-4. Well-to-Well Resistivity Inversion Model Results for the TY Tank Farm

Figure 2-5. Well-to-Well Resistivity Inversion Model Results for the TX Tank Farm

2.6 Conceptual Model

PNNL-16005 describes the conceptual model for WMA TX-TY. The conceptual model illustrates the complexity and the spatial and temporal relationships of five important parameters, which are outlined in this section:

- Contaminant sources
- Driving forces
- Migration pathways to groundwater
- Changes in groundwater flow direction and flow rate
- Current contaminant distributions in the aquifer

2.6.1 Contaminant Sources

Several potential sources for groundwater contamination exist in WMA TX-TY, including tank leaks; liquid wastes disposed to past-practice facilities (located east, west, and south of the WMA); unplanned releases, including leaking pipelines; and regional contamination from far-field sources (e.g., PFP).

- All tanks in WMA TX-TY have been interim stabilized; thus, the impact of future, large tank leaks on groundwater is not a threat. However, contaminants remaining in the vadose zone from past tank leaks have the potential to migrate to the groundwater.

- Pipeline leaks have been suggested to account for some near-surface and deeper vadose zone contamination in WMA TX-TY (RPP-7218, *Preliminary Inventory Estimates for Single-Shell Tank Leaks in T, TX, and TY Tank Farms*). Any contamination remaining in the vadose zone from past pipeline leaks or overfill events remains a possible source for future groundwater contamination.

- Regional sources are responsible for most of the carbon tetrachloride and much of the nitrate found in groundwater beneath WMA TX-TY. An exception exists for a probable nearby source for the extremely high contamination immediately east of the WMA.

2.6.2 Driving Forces

In general, contaminants are transported to groundwater in two ways: (1) transport associated with very large leaks, when the amount of liquid is sufficient to reach groundwater through gravitational forces and capillary action; and (2) transport associated with an external source of water (or other liquid) available to remobilize residual waste in vadose zone plumes. The SSTs in WMA TX-TY no longer contain large amounts of liquid waste; thus, large tank leaks emanating from WMA TX-TY are not likely.

All intentional disposal of water to non-permitted facilities ceased in 1995; therefore, effluent disposal to nearby ponds, cribs, and ditches is no longer available to mobilize vadose zone contamination to the groundwater. Figure 2-6 provides the historical conceptual model showing how contamination entered the vadose zone and possibly entered the groundwater system. All known water lines at WMA TX-TY have been tested and cut off (DOE/ORP-2008-01, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*). It is possible, but unlikely, that a previously unidentified water line will leak and substantially mobilize the existing vadose zone contamination to groundwater in the area.

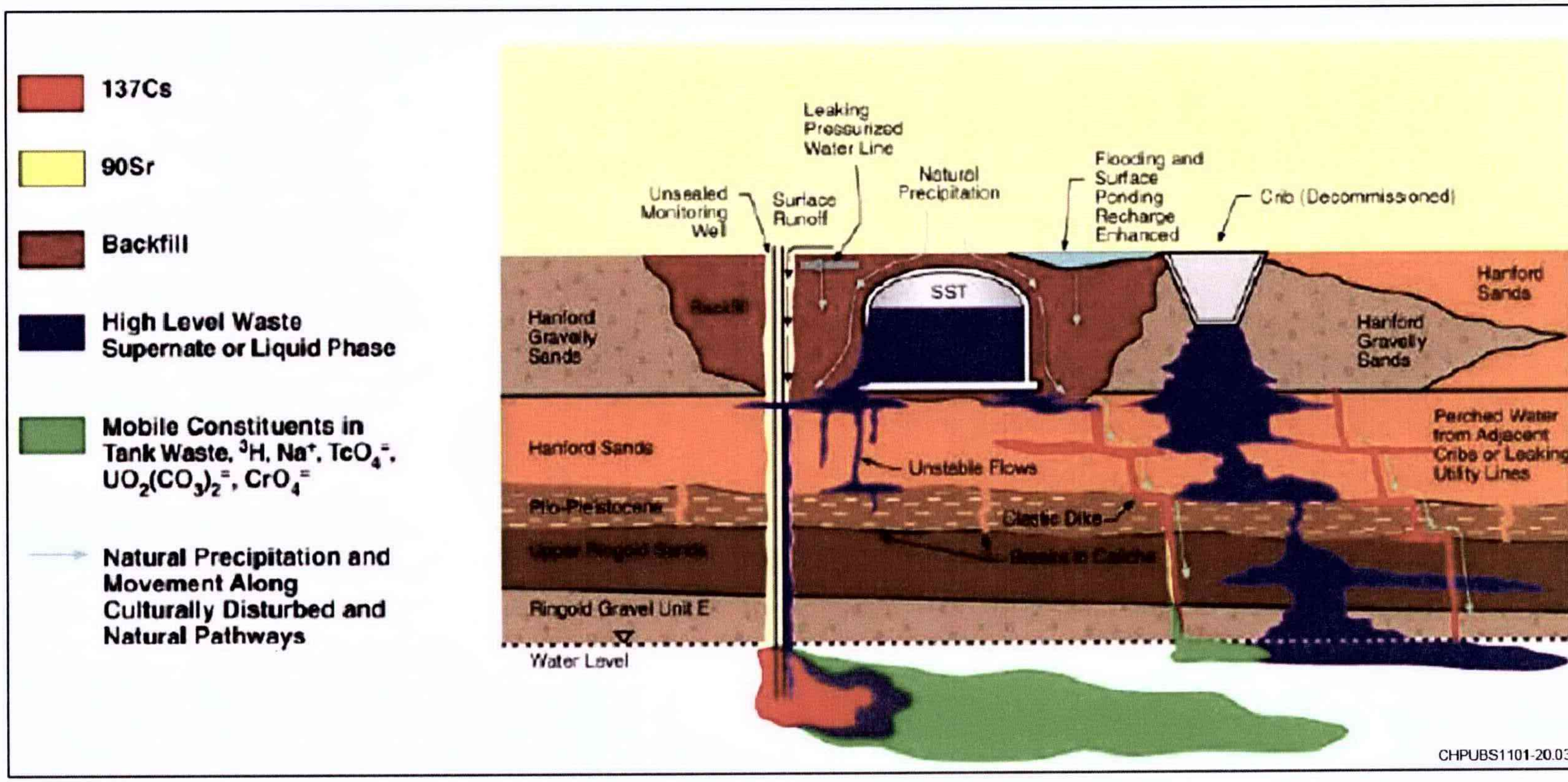


Figure 2-6. Conceptual Model of Hydraulic Drivers at Single-Shell Tank Farms

Infiltration of natural precipitation remains the likely principal driver to mobilize vadose zone contamination. Steps have been taken to reduce infiltration or precipitation at WMA TX-TY. Berms have been erected around the tank farm to stop run-on of rain and melting snow. In CY 2009, a design for an interim surface barrier for the TY Tank Farm was completed. The *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989) Milestone M-045-92 requires that interim surface barrier be completed by the end of FY 2010. As of December 2010, the interim surface barrier was operational.

2.6.3 Migration

Contaminant migration through the vadose zone is not well understood because it is highly dependent on heterogeneities and anisotropy in the soil properties. Heterogeneities at smaller than formation scale also affect flow and transport, as evidenced by logs of drywells and cone penetrometer logs that reveal moisture-rich strata, likely reflecting finer grained units with permeability contrast.

The most influential sediment layer for moisture migration through the vadose zone beneath WMA TX-TY is the Cold Creek unit. The relatively low permeability of the Cold Creek unit is expected to impede vertical moisture migration. The Cold Creek unit is known to pond water locally in several places in the 200 West Area.

Improperly sealed wells can act as a preferential pathway through the vadose zone. Documentation provided in *Hanford Wells* (PNL-8800) identified that only 6 of the 95 vadose zone wells in the TX Tank Farm and none of the vadose zone wells in the TY Tank Farm used for secondary leak detection have been modified to retrofit an annular seal. Therefore, the potential exists for unsealed wells to promote vertical moisture migration in WMA TX-TY.

Lateral migration of effluent beneath past-practice liquid disposal facilities has been documented east of WMA TX-TY at the 216-T-26 through 216-T-28 Cribs (ARH-ST-156, *Evaluation of Scintillation Probe Profiles from 200 Area Crib Monitoring Wells: Volume I*).

The groundwater flow direction and rate at WMA TX-TY is variable, depending on location relative to the 200-ZP-1 OU pump-and-treat extraction wells.

2.6.4 Changing Groundwater Flow Direction

Prior to startup of the 200-ZP-1 OU pump-and-treat system, large changes occurred in groundwater flow direction beneath WMA TX-TY during Hanford Site operations. Groundwater could have traveled and carried contaminants from WMA TX-TY and nearby past-practice disposal facilities. The approximate travel directions identified in PNNL-16005 are south (between 1954 and 1956), northeast (between 1957 and 1982), and north or northwest (between 1983 and 1995). Since 1995, groundwater flow direction has been primarily toward the east, except where influenced by the 200-ZP-1 OU pump-and-treat system. These changes in the groundwater flow direction could have contributed to relatively widespread contaminant distribution.

An expanded, large-scale pump-and-treat system is being installed in the 200 West Area. The expanded system is expected to change the groundwater flow direction and flow velocity at WMA TX-TY in the future. However, the magnitude and direction of the changes will not be known until after the system becomes operational in 2011 or 2012.

2.6.5 Contaminant Distribution

The current understanding of the spatial distribution of contaminants at WMA TX-TY is shown in recent plume maps (DOE/RL-2010-11). Several lines of evidence show that vertical contaminant concentration gradients exist in the area of downgradient wells 299-W14-11 and 299-W14-13.

2.7 Data Quality Objectives

To define the required information for groundwater indicator evaluation monitoring, the data quality objectives (DQO) process is used to ensure that data gathered are of the appropriate quantity and quality to meet specific objectives. The DQOs for the groundwater quality assessment at WMA TX-TY are presented in PNNL-16005.

The current groundwater monitoring network for WMA TX-TY is a result of previous investigations and DQO processes. Assessment monitoring is now ongoing at the WMA in accordance with interim status regulations. Table 2-2 provides a matrix of data requirements that are typically determined by the DQO process, the associated interim status regulations applicable to these requirements, and the current and historical documentation specifying how the monitoring program for WMA TX-TY complies with the requirements.

Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA TX-TY

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Scope	**40 CFR 265; incorporated by reference in WAC 173-303-400(3)(a), as modified by WAC 173-303-400(3)(b) and WAC 173-303-400(3)(c)(v)(E).** **40 CFR 265.93, "Preparation, Evaluation, and Response."** (d)(7) If the owner or operator determines…that hazardous waste or hazardous waste constituents from the facility have entered the ground-water, then the owner or operator: (i) Must continue to make the determinations required under paragraph (d)(4) of this section… **40 CFR 265.93, Preparation, Evaluation, and Response."** (d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine: (i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and (ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water. **40 CFR 265.93, "Preparation, Evaluation, and Response."** (d)(3) The plan to be submitted under 40 CFR 265.90(d)(1) or paragraph (d)(2) of this section must specify: (i) The number, location, and depth of wells; (ii) Sampling and analytical methods for those hazardous wastes or hazardous waste constituents in the facility; (iii) Evaluation procedures, including any use of previously gathered ground-water quality information; and (iv) A schedule of implementation.	This plan, Sections 3.1 and 3.2, Chapter 4, and Appendix A PNNL-16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*

Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA TX-TY

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Number and location of wells Point(s) of compliance	**40 CFR 265.93, "Preparation, Evaluation, and Response."** (d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine: (i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and (ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water.	This plan, Chapters 1 and 3, and Appendix A PNNL--16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*
Well configuration (depth and length of screened interval; well construction)	**40 CFR 265.91, "Ground-Water Monitoring System."** (c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand where necessary; to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground-water. **Additional Requirements from WAC 173-303-400(3)(c)(v)(C).** Ground-water monitoring wells must be designed, constructed, and operated so as to prevent ground water contamination. WAC 173-160 may be used as guidance in the installation of wells.	This plan, Section 3.2 and Appendix A PNNL-16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*
Frequency of sampling Types of analysis or measurement Method detection limits or accuracy and precision Methods used to evaluate the collected data	**40 CFR 265.93, "Preparation, Evaluation, and Response."** (d)(7) If the owner or operator determines…that hazardous waste or hazardous waste constituents from the facility have entered the ground-water, then the owner or operator: (i) Must continue to make the determinations required under paragraph (d)(4) of this section <u>on a quarterly basis</u> until final closure of the facility, if the ground-water quality assessment plan was implemented prior to final closure of the facility; or (ii) May cease to make the determinations required under paragraph (d)(4) of this section, if the ground-water quality assessment plan was implemented during the post-closure care period.	This plan, Section 3.1, Chapter 4, and Appendix A PNNL-16005, *RCRA Assessment Plan for Single-Shell Tank Waste management Area TX-TY*

Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA TX-TY

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
	40 CFR 265.93, "Preparation, Evaluation, and Response." (d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) *[see scope in first row of this table]* of this section, and, at a minimum, determine: (i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and (ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water.	

Notes: The references cited in this table are listed in the reference section (Chapter 5) of this plan.

3 Groundwater Monitoring Program

This chapter lists the wells monitored, constituents analyzed, and sampling frequency for WMA TX-TY. The quality assurance and quality control requirements are provided in the QAPjP (Appendix A).

3.1 Constituent List and Sampling Frequency

The constituent list for groundwater sampling consists of RCRA-regulated analytes that may be present in SST waste. To identify these analytes, the list of primary nonradiological constituents potentially present in SST waste (RPP-23403, *Single-Shell Tank Component Closure Data Quality Objectives*) was compared to those constituents listed in Appendix 5 of Ecology Publication 97-407 (*Chemical Testing Methods for Designating Dangerous Waste: WAC 173-303-090 & -100*), which references 40 CFR 264, Appendix IX ("Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring List"). Those constituents identified in RPP-23403 that are RCRA-regulated (i.e., listed in Appendix 5 of Ecology Publication 97-407) are included in Table 3-1.

Table 3-1. RCRA-Regulated Constituents Potentially Present in the Single-Shell Tank Farm System

Constituent	CAS ID	Constituent	CAS ID
Volatile Organic Compounds			
1,1,1-Trichloroethane	71-55-6	Chloroform	67-66-3
1,1,2,2-Tetrachloroethane	79-34-5	Ethylbenzene	100-41-4
1,1,2-Trichloroethane	79-00-5	Isobutanol	78-83-1
1,1-Dichloroethene	75-35-4	Methylene chloride	75-09-2
1,2-Dichloroethane	107-06-2	Tetrachloroethene	127-18-4
2-Butanone (methyl ethyl ketone)	78-93-3	Toluene	108-88-3
2-Propanone (acetone)	67-64-1	trans-1,3-Dichloropropene	10061-02-6
4-Methyl-2-pentanone (MIBK)	108-10-1	Trichloroethylene (TCE)	79-01-6
Benzene	71-43-2	Trichlorofluoromethane	75-69-4
Carbon disulfide	75-15-0	Vinyl chloride (chloroethene)	75-01-4
Carbon tetrachloride	56-23-5	Xylenes	1330-20-7
Chlorobenzene	108-90-7		
Semivolatile Organic Compounds			
1,2,4-Trichlorobenzene	120-82-1	Aroclor 1260	11096-82-5
2,4,5-Trichlorophenol	95-95-4	Butylbenzylphthalate	85-68-7
2,4,6-Trichlorophenol	88-06-2	Di-n-butylphthalate	84-74-2
2,4-Dinitrotoluene	121-14-2	Di-n-octylphthalate	117-84-0

Table 3-1. RCRA-Regulated Constituents Potentially Present in the Single-Shell Tank Farm System

Constituent	CAS ID	Constituent	CAS ID
2-Chlorophenol	95-57-8	Fluoranthene	206-44-0
2-Methylphenol (o-cresol)	95-48-7	Hexachlorobutadiene	87-68-3
3-Methylphenol (m-Cresol)	108-39-4	Hexachloroethane	67-72-1
4-Chloro-3-methylphenol (p-Chloro-m-cresol)	59-50-7	Naphthalene	91-20-3
4-Methylphenol (p-cresol)	106-44-5	Nitrobenzene	98-95-3
Acenaphthene	83-32-9	n-Nitroso-di-n-propylamine	621-64-7
Aroclor 1016	12674-11-2	n-Nitrosomorpholine	59-89-2
Aroclor 1221	11104-28-2	1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1
Aroclor 1232	11141-16-5	2-Nitrophenol (o-Nitrophenol)	88-75-5
Aroclor 1242	53469-21-9	Pyrene	129-00-0
Aroclor 1248	12672-29-6	Pyridine	110-86-1
Aroclor 1254	11097-69-1		
Inorganic Constituents (Nonradiological)			
Antimony (Sb)	7440-36-0	Mercury (Hg)	7439-97-6
Arsenic (As)	7440-38-2	Nickel (Ni)	7440-02-0
Barium (Ba)	7440-39-3	Selenium (Se)	7782-49-2
Beryllium (Be)	7440-41-7	Silver (Ag)	7440-22-4
Cadmium (Cd)	7440-43-9	Sulfide (S^{2-})	18496-25-8
Chromium (Cr)	7440-47-3	Thallium (Tl)	7440-28-0
Cobalt (Co)	7440-48-4	Vanadium (V)	7440-62-2
Copper (Cu)	7440-50-8	Zinc (Zn)	7440-66-6
Cyanide (CN^-)	57-12-5		
Lead (Pb)	7439-92-1		

Notes: This table lists the primary nonradiological constituents provided in RPP-23403 that are regulated by RCRA (i.e., also listed in Appendix 5 of Ecology Publication 97-407).

One of the 72 analytes listed in Table 3-1, chromium, has been found in groundwater and is attributed to releases from the WMA only; in addition, nitrate is present in groundwater and a portion is attributed to WMA TX-TY (see Section 2.5.1). Carbon tetrachloride and TCE are also found in the groundwater but originate from waste sites associated with the PFP. Thus, chromium and the supporting constituents alkalinity, nitrate, major cations (metals), and major anions are routinely sampled for RCRA in the network monitoring wells (Table 3-2). The supporting constituents provide information on general chemistry and allow for charge-balance computations to assess laboratory performance.

Sampling for the remaining constituents identified in Table 3-1 will be performed once during the first available sample event after this plan is in effect to determine if these constituents have impacted groundwater quality. Sampling will be performed in the recent historical upgradient and near-field downgradient monitoring wells (Table 3-2). The constituents not detected in groundwater will be removed from future sampling. If an organic constituent from Table 3-1 is detected in a groundwater sample and it is not attributed to contamination from another facility (e.g., carbon tetrachloride from the PFP), a confirmation sample will be collected at the next scheduled sample event, with split samples sent to different analytical laboratories. If the detection is confirmed by positive results from both laboratories, the constituent will be added to the list of analytes for routine sampling to evaluate the extent of contamination. If the detection is not confirmed, the analyte will be removed from future sampling.

Some of the inorganic constituents included in Table 3-1 occur naturally in groundwater (e.g., barium, selenium, vanadium, and zinc). Detections of an inorganic constituent will be evaluated to determine if the constituent is present naturally by comparison to sample results from the upgradient wells and comparisons to Hanford Site background values (DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*). If it is determined that an inorganic constituent may be present as a contaminant from the WMA, confirmation samples will be collected (as described for the organic constituents). If contamination is confirmed, then the constituent will be added to the routine sample list to evaluate the extent of contamination. If the contamination is not confirmed, the constituent will be removed from future sampling.

3.2 Monitoring Well Network

Figure 3-1 shows the groundwater monitoring well network for WMA TX-TY. Table 3-2 lists the wells in the groundwater monitoring network, including the constituents and sampling frequency. Some of the wells in the WMA TX-TY monitoring network are also sampled for the 200-ZP-1 OU. Sampling for WMA TX-TY and the 200-ZP-1 OU is coordinated to eliminate duplicate analyses and well trips. Wells are to be sampled quarterly or semiannually each year. Maintenance problems and sampling logistics sometimes delay scheduled sampling events. If a sampling event is delayed more than 6 weeks, that sample may be cancelled because it is nearly time for the next quarterly sampling.

Table 3-2 indicates the purpose of each well and whether the wells meet WAC requirements. Table 3-3 summarizes well construction information, including the current (March 2010) water table elevations in each well. As-built diagrams for the wells showing construction details are available in PNNL-16005. Wells installed since the 1980s are constructed to meet the requirements of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells." These wells have stainless-steel casing and screen, sand pack in the screened interval, and full annular seal above. Other wells in the network are much older and were installed before the requirements of WAC 173-160 were implemented. These wells have carbon-steel casings and perforated intervals rather than screens. In some cases, wells were later retrofit with annular seals at the surface. The use of the older wells permits continuity with historical data. Given the current rate of water table decline (0.3 to 0.4 m/yr [0.98 to 1.3 ft/yr]), well 299-W14-6 went dry in 2010, and well 299-15-41 will be dry in 2011 or 2012 (Table 3-3).

Table 3-2. Monitoring Network, Constituent List, and Sampling Frequency for WMA TX-TY

				RCRA Dangerous Constituents	Supporting Parameters				Field-Measured Parameters					
Well Name	**Purpose[a]**	**WAC-Compliant**	**Water Level[b]**	**Hexavalent Chromium**	**Nitrate (Anions)**	**Metals, Unfiltered[c]**	**Anions[d]**	**Alkalinity**	**pH[b]**	**Specific Conductance[b]**	**Turbidity[b]**	**Temperature[b]**	**Dissolved Oxygen[b]**	**Table 3-1 Analytes**
299-W10-26	Downgradient	Y	Q	Q	SA	SA	SA	SA	Q	Q	Q	Q	Q	Once
299-W10-27	Downgradient	Y	Q	Q	SA	SA	SA	SA	Q	Q	Q	Q	Q	Once
299-W14-11	Downgradient	Y	Q	Q	SA	SA	SA	SA	Q	Q	Q	Q	Q	Once
299-W14-13	Downgradient	Y	Q	Q	SA	SA	SA	SA	Q	Q	Q	Q	Q	Once
299-W14-14	Downgradient	Y	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	Once
299-W14-15	Downgradient	Y	Q	Q	SA	SA	SA	SA	Q	Q	Q	Q	Q	Once
299-W14-16	Far-field[a]	Y	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	Once
299-W14-17	Far-field[a]	Y	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	Once
299-W14-18	Downgradient	Y	Q	Q	SA	SA	SA	SA	Q	Q	Q	Q	Q	Once
299-W14-19	Downgradient	Y	SA	SA	SA	A	SA	SA	SA	SA	SA	SA	SA	Once
299-W15-40	Upgradient	Y	NA[e]	Q	SA	SA	SA	SA	Q	Q	Q	Q	Q	Once
299-W15-41	Downgradient	Y	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	Once
299-W15-44	Downgradient	Y	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	Once
299-W15-763	Downgradient	Y	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA	Once
299-W15-765	Upgradient	Y	NA[e]	Q	SA	SA	SA	SA	Q	Q	Q	Q	Q	Once

Table 3-2. Monitoring Network, Constituent List, and Sampling Frequency for WMA TX-TY

Well Name	Purpose[a]	WAC-Compliant	Water Level[b]	RCRA Dangerous Constituents	Supporting Parameters				Field-Measured Parameters					Table 3-1 Analytes
				Hexavalent Chromium	Nitrate (Anions)	Metals, Unfiltered[c]	Anions[d]	Alkalinity	pH[b]	Specific Conductance[b]	Turbidity[b]	Temperature[b]	Dissolved Oxygen[b]	

Notes:

1. Bold/italic print indicates upgradient monitored extraction wells.
2. Abbreviations in this table include the following:

A = to be sampled annually (performed in November)

Q = to be sampled quarterly

SA = to be sampled semiannually

a. Far-field wells are wells located farther downgradient and used to determine lateral extent of contamination.

b. Field measurement.

c. Metals; analytes include, but are not limited to, aluminum, chromium, sodium, magnesium, potassium, and calcium.

d. Anions; analytes include, but are not limited to, nitrate, chloride, sulfate, and fluoride.

e. Water levels are not measured in extraction wells.

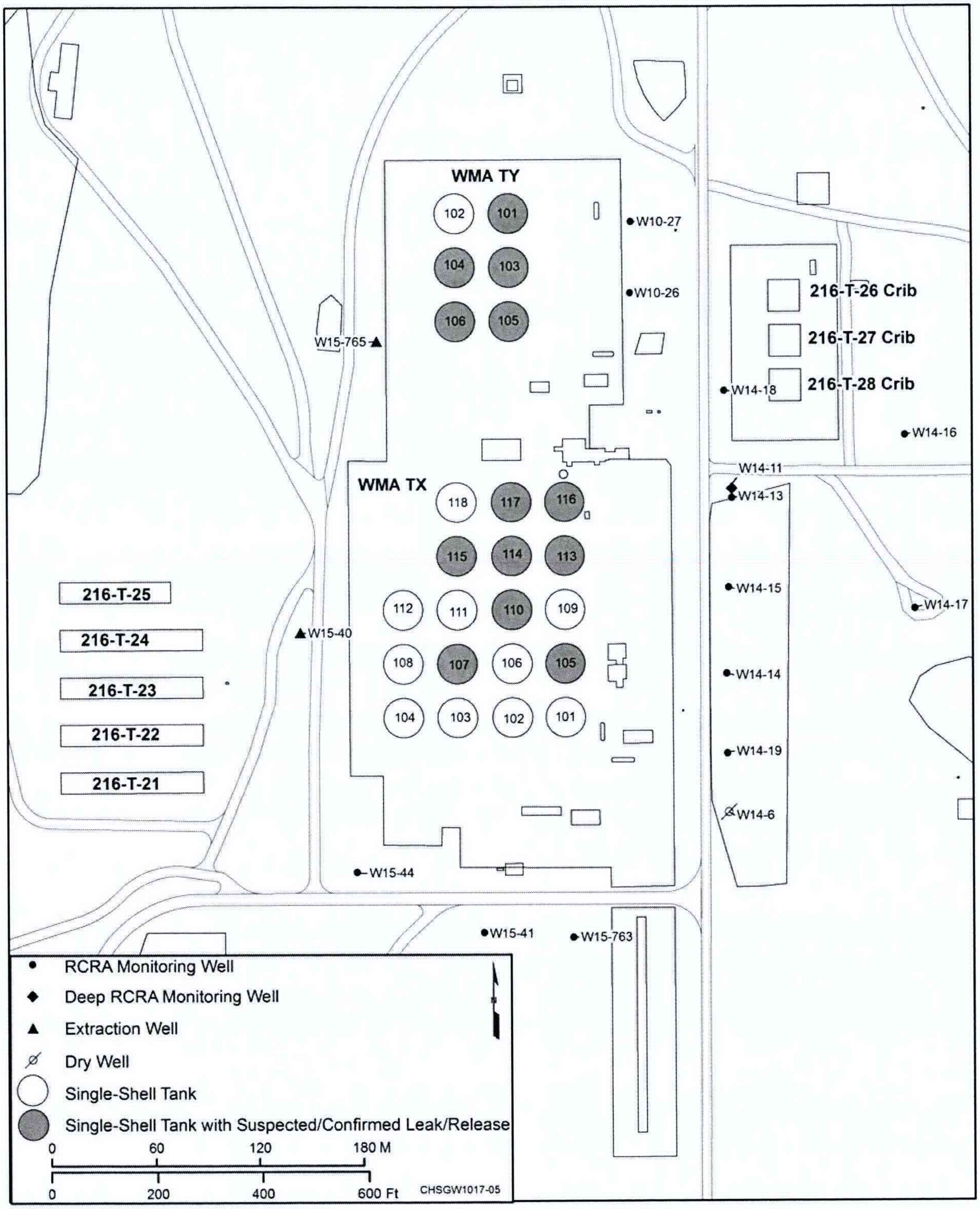


Figure 3-1. General Layout of WMA TX-TY, Including Locations of Nearby Past-Practice Facilities and Monitoring Wells

Table 3-3. WMA TX-TY Well Depths and Water Table Elevations

Well Name	Completion Date	Surface Elevation NAVD88, amsl (m)	Water Table Elevation (m), March 2010	Open Interval Bottom Elevation (m)	Water Column (m), March 2010
299-W10-26	1998	204.63	134.26	127.78	6.48
299-W10-27	2001	204.90	134.22	126.90	7.32
299-W14-11	2005	203.00	134.21	120.20	14.01
299-W14-13	1998	204.35	134.22	127.62	6.60
299-W14-14	1998	204.62	134.20	127.81	6.39
299-W14-15	2000	204.58	134.15	126.97	7.18
299-W14-16	2000	205.37	134.19	126.77	7.42
299-W14-17	2000	205.08	134.10	126.76	7.34
299-W14-18	2000	204.26	134.23	127.13	7.10
299-W14-19	2002	204.90	134.28	126.11	8.18
299-W15-40	1998	205.06	NA	127.92	NA
299-W15-41	1999	202.79	133.91	132.40	1.51
299-W15-44*	2002	204.17	134.2	127.59	6.51
299-W15-763	2001	202.18	133.98	126.95	7.03
299-W15-765	2001	204.51	NA	126.79	NA

Notes:

1. Bold/italic print indicates upgradient wells.
2. Used water level measurement taken during sampling after well was converted from extraction to monitoring well in August 2010.

* Water-level measurement used was from measurement taken during sampling after well was converted from extraction to monitoring well in August 2010.

Wells 299-W15-40 and 299-W15-765 were considered true upgradient monitoring wells prior to their conversion to pump-and-treat extraction wells in 2005. No other wells are currently upgradient for RCRA compliance. Due to fluctuating local groundwater gradients and flow directions, as well as capture zones created by extraction wells in the area, the addition or construction of compliant upgradient monitoring wells will be difficult. As previously discussed, the expansion of the 200-ZP-1 OU pump-and-treat system is scheduled for completion in 2011 or 2012. After the expanded pump-and-treat system is operational, the system will further impact the hydrologic conditions near WMA TX-TY.

It can be assumed that contamination upgradient of the WMA would be captured by the current extraction wells. Plumes localized to WMA TX-TY will either be captured by the current extraction wells or will continue to migrate via groundwater downgradient and be detected by the downgradient monitoring wells. This assumption will be part of the ongoing analysis of groundwater sampling data and pump-and-treat system performance until data from the larger scale, expanded system can be analyzed once the system is operational.

3.3 Changes to Monitoring Plan

Several changes have been made to the sampling frequency at WMA TX-TY since the previous plan (PNNL-16005) was issued. Well 299-W14-6 has been removed from the network because became dry in 2010 due to decreasing water levels (Section 3.2). Hexavalent chromium analyses have been added quarterly or semiannually at all downgradient wells and semiannually to upgradient wells. This allows elimination of filtered metals analyses so only unfiltered metals will be sampled in the future. The sampling frequency for many constituents has been changed as follows:

- Former upgradient (west) wells 299-W15-40 and 299-W15-765 are no longer considered upgradient of the WMA. These wells are currently 200-ZP-1 OU pump-and-treat extraction wells and will remain on a quarterly sampling frequency.
- Near-field downgradient wells 299-W14-14 and 299-W14-19 have been changed from quarterly to semiannual sampling.
- Mid-field downgradient wells 299-W14-16 and 299-W14-17 have been changed from quarterly to semiannual sampling.
- Near-field downgradient wells 299-W15-41, 299-W15-44, and 299-W15-763 south of WMA TX-TY have been changed from quarterly to semiannual sampling.

Table 3-4 presents the sampling frequencies for all wells in the monitoring network and further describes the rationale for changes in frequency to applicable wells.

Table 3-4. WMA TX-TY Monitoring Well Network Sample Frequencies

Well	Sample Frequency	Rationale
299-W10-26, 299-W10-27, 299-14-11, 299-W14-13, 299-W14-15, and 299-14-18	Quarterly	Near-field downgradient monitoring wells located within higher concentration areas of existing dangerous constituent chromium and supporting constituent nitrate (RCRA) contaminant plumes that have exhibited substantial constituent concentration variability. A quarterly frequency is needed to track concentration variations near edges of contaminant plumes.
299-W14-14 and 299-W14-19	Semiannually	Near-field downgradient monitoring wells located outside of higher concentration areas of RCRA contaminant plumes.
299-W14-16 and 299-W14-17,	Semiannually	Far-field downgradient monitoring wells located outside RCRA contaminant plumes.
299-W15-41, 299-W15-44, and 299-W15-763	Semiannually	Near-field downgradient monitoring wells south of the WMA in low- to medium-concentration areas of existing RCRA contaminant plumes.

Table 3-4. WMA TX-TY Monitoring Well Network Sample Frequencies

Well	Sample Frequency	Rationale
299-W15-40 and ***299-W15-765***	Quarterly	Former upgradient wells previously monitored to establish background water quality conditions. The wells are currently also used as extraction wells for the 200-ZP-1 OU pump-and-treat system and are sampled semiannually under CERCLA decision requirements (DOE/RL-2002-17).

Notes: Bold/italic print indicates upgradient monitoring wells that have been converted to remedial extraction wells.

3.4 Sampling and Analysis Protocol

Sampling and analysis protocols at WMA TX-TY follow the conventions of the project and are described in the QAPjP (Appendix A).

4 Data Evaluation and Reporting

This chapter discusses data evaluation and reporting for WMA TX-TY.

4.1 Data Review

Data review, validation, and verification are discussed in the QAPjP in Appendix A.

4.2 Interpretation

After data are validated and verified, acceptable data are used to interpret groundwater conditions at WMA TX-TY. Interpretive techniques include the following:

- **Hydrographs:** Graph water levels versus time to determine decreases, increases, seasonal, or manmade fluctuations in groundwater levels.
- **Water table maps:** Use water table elevations from multiple wells to construct contour maps and to estimate flow directions. Groundwater flow is assumed to be perpendicular to lines of equal potential.
- **Trend plots:** Graph concentrations of constituents versus time to determine increases, decreases, and fluctuations. May be used in tandem with hydrographs and/or water table maps to determine if concentrations relate to changes in water level or in groundwater flow directions.
- **Plume maps:** Map distributions of chemical constituent concentrations in the aquifer to determine extent of contamination. Changes in plume distribution over time assist in determining plume movement and direction of groundwater flow.
- **Contaminant ratios:** Can sometimes be used to distinguish among different sources of contamination.

4.3 Annual Determination of Monitoring Network

The RCRA groundwater monitoring requirements include an annual evaluation of the monitoring well network to determine if it remains adequate to monitor the WMA. The groundwater flow direction beneath WMA TX-TY is variable, depending on the location and proximity to extraction wells.

Water-level measurements will continue to be collected before each sampling event, and more comprehensive measurements will continue to be made in the northern portion of the 200 West Area in March of each year. The measurements are corrected, if needed, to account for borehole deviation from vertical, and the resulting data are plotted on a map. The data are presented in the annual Hanford Site groundwater monitoring report (e.g., DOE/RL-2010-11).

Well 299-W14-6 went dry in 2010 and has been removed from the network. Most other wells in the WMA TX-TY monitoring network are not expected to go dry for several years; however, well 266-W15-41 has less than 2 m (6.6 ft) of water remaining and may be dry for sampling purposes within 3 years. Impact from the expanded 200-ZP-1 OU pump-and-treat system may cause an increase in the rate of water-level declines in all wells, which will continue to be evaluated.

The RCRA monitoring will conduct assessment studies and create work plans to install new wells if necessary. Alternatives to new well construction include well network analysis using statistical methods to determine if new wells are needed to replace drywells. Well-deepening technical evaluations are ongoing and recommendations are forthcoming. The 200-ZP-1 OU performance monitoring results and recommendations will be evaluated after the pump-and-treat system is operational.

Any new RCRA wells needed at WMA T will be negotiated and prioritized by Ecology, DOE, and EPA and approved under *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989) Milestone M-24-00.

4.4 Reporting and Notification

Results of assessment monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, “Recordkeeping and Reporting.” Reporting will be in the annual Hanford Site groundwater monitoring report.

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Appendix A

Quality Assurance Project Plan

Contents

Figure

Tables

Terms

CRDL	contract-required detection limit
DOE	U.S. Department of Energy
DQO	data quality objective
DUP	laboratory matrix duplicate
EB	equipment blank
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FTB	full trip blank
FXR	field transfer blank
GC	gas chromatography
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Documents*
HEIS	Hanford Environmental Information System
IC	ion chromatography
ICP	inductively coupled plasma
ICP/MS	inductively coupled plasma/mass spectrometry
LCS	laboratory control sample
MB	method blank
MDA	minimum detectable activity
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
PCB	polychlorinated biphenyl
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RL	U.S. Department of Energy, Richland Operations Office
RPD	relative percent difference
RSD	relative standard deviation
SUR	surrogate

TOC	total organic carbon
TOX	total organic halides
TPA	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and disposal
VOC	volatile organic compound

A Quality Assurance Project Plan

The contractor's quality assurance (QA) program describes the contractor's QA structure, requirements, implementation methods, and responsibilities. The contractor's environmental QA program plan provides the requirements for collecting and assessing environmental data in accordance with the following:

- 10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements"
- DOE O 414.1C, *Quality Assurance*
- DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD)
- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*

This quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection including the planning, implementation, and assessment of sampling, field measurements, and laboratory analyses. Section 6.5 and 7.8 of the *Hanford Federal Facility Agreement and Consent Order* (TPA) (Ecology et al., 1989a), Attachment 2, "Action Plan," require that QA/quality control (QC) and sampling and analysis activities specify the QA requirements for treatment, storage, and disposal (TSD) units, as well as for past-practice processes. The HASQARD requirements (DOE/RL-96-68) also apply to this work.

The content of this QAPjP is patterned after the QA elements of EPA/240/B-01/003. The QAPjP demonstrates conformance to the Part B requirements of *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use* (ANSI/ASQ E4-2004). This QAPjP is divided into four sections (as designated in EPA/240/B-01/003) that describe the quality requirements and controls applicable to this investigation. This QAPjP is intended to supplement the contractor's environmental QA program plan.

A1 Project Management

This section addresses the basic aspects of project management and will ensure that the project has defined goals, the participants understand the goals and the approaches used, and the planned outputs are appropriately documented.

A1.1 Project/Task Organization

The project organization in regard to planning, sampling, analysis, and data assessment is described in the following subsections and is shown in Figure A-1. For each functional primary contractor role, there is a corresponding oversight role within the U.S. Department of Energy (DOE).

A1.1.1 Regulatory Project Manager

The Washington State Department of Ecology (Ecology) project manager is responsible for oversight of the work being performed under this groundwater monitoring plan. Ecology will work with the DOE Richland Operations Office (RL) to resolve concerns regarding the work as described in this QAPjP. Ecology can request this plan during a regulatory compliance inspection for review.

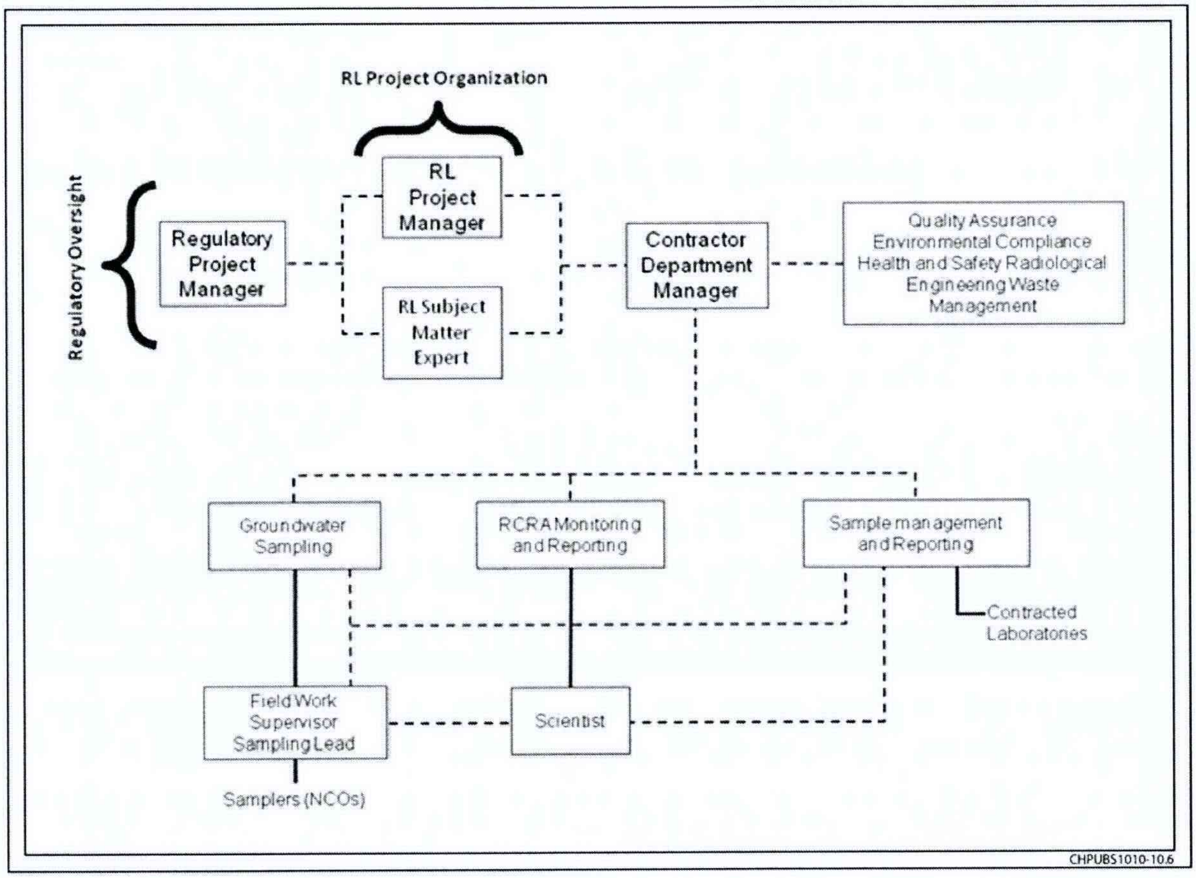

Figure A-1. Project Organization

A1.1.2 U.S. Department of Energy, Richland Operations Office Project Manager

Hanford Site cleanup is the responsibility of RL. The RL project manager is responsible for authorizing the contractor to perform activities under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*; the *Resource Conservation and Recovery Act of 1976* (RCRA); the *Atomic Energy Act of 1954*; and the TPA (Ecology et al., 1989a) for the Hanford Site.

A1.1.3 U.S. Department of Energy, Richland Operations Office Subject Matter Expert

The RL subject matter expert is responsible for day-to-day oversight of the contractor's performance of workscope, for working with the contractor and the regulatory agencies to identify and work through issues, and for providing technical input to the RL project manager.

A1.1.4 Contractor Groundwater Remediation Department Manager

The contractor groundwater remediation department manager provides oversight for all activities and coordinates with DOE, the regulatory agencies, and primary contractor management in support of sampling and reporting activities. The remediation department manager also provides support to the RCRA Monitoring and Reporting manager to ensure that work is performed safely and cost effectively.

A1.1.5 Groundwater Sampling Operations

Groundwater sampling operations is responsible for planning and coordinating field sampling resources and provides the field work supervisor for routine groundwater sampling operations. The field work supervisor directs the samplers who collect groundwater samples in accordance with the sampling and analysis plan and in accordance with corresponding standard procedures and work packages. The samplers also complete field logbooks and chain-of-custody forms, including any shipping paperwork, and ensure delivery of the samples to the analytical laboratory.

A1.1.6 RCRA Monitoring and Reporting

The RCRA Monitoring and Reporting manager is responsible for direct management of activities performed to meet RCRA TSD monitoring requirements. The RCRA Monitoring and Reporting manager coordinates with and reports to DOE and primary contractor management regarding RCRA TSD monitoring requirements. The RCRA Monitoring and Reporting manager assigns scientists to provide technical expertise.

A1.1.7 Sample Management and Reporting Organization

The Sample Management and Reporting organization coordinates laboratory analytical work to ensure that laboratories conform to HASQARD requirements (or their equivalent), as approved by DOE, the U.S. Environmental Protection Agency (EPA), and Ecology. Sample Management and Reporting receives analytical data from the laboratories, performs data entry into the Hanford Environmental Information System (HEIS) database, and arranges for data validation. Sample Management and Reporting is responsible for informing the RCRA Monitoring and Reporting manager of any issues reported by the analytical laboratories.

A1.1.8 Contract Laboratories

The contract laboratories analyze samples in accordance with established procedures and provide necessary sample reports and explanations of results to support data validation. The laboratories must meet site-specific QA requirements and must have an approved QA plan in place.

A1.1.9 Quality Assurance

The QA point of contact is matrixed to the subject matter expert and is responsible for QA issues on the project. Responsibilities include overseeing implementation of the project QA requirements; reviewing project documents, including data quality objective (DQO) summary reports, sampling and analysis plans, and the QAPjP; and participating in QA assessments on sample collection and analysis activities, as appropriate. The QA point of contact must be independent of the unit generating the data.

A1.1.10 Environmental Compliance Officer

The environmental compliance officer provides technical oversight, direction, and acceptance of project and subcontracted environmental work, and also develops appropriate mitigation measures with the goal of minimizing adverse environmental impacts.

A1.1.11 Health and Safety

The Health and Safety organization is responsible for coordinating industrial safety and health support within the project as carried out through health and safety plans, job hazard analyses, and other pertinent safety documents required by federal regulations or by internal primary contractor work requirements.

A1.1.12 Waste Management

Waste Management communicates policies and procedures and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner.

A1.2 Problem Definition/Background

The problem definition, as required by WAC 173-303-400 ("Dangerous Waste Regulations," "Interim Status Facility Standards") and 40 CFR 265, Subpart F ("Interim Status Standards for Owners and

Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring"), is outlined in the main text discussion of this monitoring plan. The background is also provided in the monitoring plan.

A1.3 Project/Task Description

The project description is provided in Chapters 3 and 4 of this monitoring plan and includes the selection of appropriate dangerous waste or dangerous waste constituents, collection and analyses of groundwater from the monitoring network, interpretation of analytical results, evaluation of the monitoring network, and reporting.

The target analytes, along with the monitoring wells and frequency of sampling, are provided in Chapter 3.

A1.4 Quality Objectives and Criteria

The quality objectives and criteria for groundwater monitoring are defined in the tables provided in this QAPjP in order to meet the evaluation requirements stated in the monitoring plan.

A1.5 Special Training/Certification

Workers receive a level of training that is commensurate with their responsibility for collecting and transporting groundwater samples according to the dangerous waste training plan maintained for the TSD unit to meet the requirements of WAC 173-303-330, "Personnel Training." The field work supervisor, in coordination with line management, will ensure that all field personnel meet training requirements.

A1.6 Documents and Records

The project scientist is responsible for ensuring that the current version of the groundwater monitoring plan is used and for providing any updates to field personnel. Version control is maintained by the administrative document control process. Significant changes to the plan that affect DQOs will be reviewed and approved by DOE and the regulatory agency prior to implementation. Table A-1 defines the types of changes that may be made to the sampling design and documentation requirements.

Logbooks and data forms are required for field activities. The logbook must be identified with a unique project name and number. Individuals responsible for the logbooks shall be identified in the front of the logbook, and only authorized individuals may make entries into the logbooks. Logbooks will be controlled in accordance with internal work requirements and processes.

The HEIS database will be identified as a data repository for the Hanford Facility Operating Record unit file. Records may be stored in either electronic or hardcopy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that ensure accuracy and retrievability of stored records. Records required by the TPA (Ecology et al., 1989a) will be managed in accordance with the requirements therein.

The results of groundwater monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2010-11, *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volumes 1 & 2*).

Table A-1. Actions and Documentation for Regulatory Notification

Type of Change	Action	Documentation
Temporary addition of wells or constituents, or increased sampling frequency	RCRA Monitoring and Reporting manager approval; notify regulatory agency, if appropriate	Project's schedule tracking system
Unintentional impact to groundwater monitoring plan including one-time missed well sampling due to operational constraints, delayed sample collection, broken pump, lost bottle set, missed sampling of indicator parameters, loss of samples in transit, etc.	Electronic notification	RCRA annual report
Planned change to groundwater monitoring activities, including addition or deletion of constituents or wells, change of sampling frequency, etc.	Revise monitoring plan	Revised RCRA groundwater monitoring plan
Anticipated unavoidable changes (e.g., dry wells)	Electronic notification; revise monitoring plan	RCRA annual report and revised groundwater monitoring plan

A2 Data Generation and Acquisition

This section addresses data generation and acquisition to ensure that the project's methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented.

A2.1 Sampling Process Design (Experimental Design)

The sampling design is based on regulatory requirements and judgmental sampling.

A2.1.1 Regulatory Requirements

The groundwater protection regulations of WAC 173-303-400 dictate the groundwater sampling and analysis requirements applicable to interim status TSD units.

A2.1.2 Judgmental Sampling

The selection of sampling and analysis requirements is based on knowledge of the feature or condition under investigation and is also based on professional judgment. The TSD unit monitoring is based on professional judgment. Conclusions depend on the validity and accuracy of professional judgment.

A2.2 Sampling Methods

Sampling is described in the contractor's environmental QA program plan, including the following:

- Field sampling methods
- Sample preservation, containers, and holding times
- Corrective actions for sampling activities
- Decontamination of sampling equipment

The groundwater sampling operations supervisor must ensure that situations that may impair the usability of samples and/or data are documented in field logbooks or on nonconformance report forms in accordance with internal corrective action procedures, as appropriate. The groundwater sampling operations supervisor will note any deviations that occur from the standard procedures for sample collection, contaminants of potential concern, sample transport, or monitoring. The groundwater sampling operations supervisor is also responsible for coordinating all activities related to the use of field monitoring equipment (e.g., dosimeters and industrial hygiene equipment). Field personnel will document in the logbook all noncompliant measurements taken during field sampling. Ultimately, the groundwater sampling operations supervisor is responsible for developing, implementing, and communicating corrective action procedures; for documenting all deviations from procedure; and for ensuring that immediate corrective actions are applied to field activities. Problems with sample collection, custody, or data acquisition that adversely impact data quality or impair the ability to acquire data or failure to follow procedure will be documented in accordance with internal corrective action procedures, as appropriate.

A2.3 Sample Handling and Custody

A sampling and data tracking database is used to track samples from the point of collection through the laboratory analysis process. Laboratory analytical results are entered and maintained in the HEIS database. Each sample is identified and labeled with a unique HEIS sample number. The contractor's environmental QA program plan specifies sample handling information, including the following:

- Container requirements
- Container labeling and tracking process
- Sample custody requirements
- Shipping and transportation

Sample custody during laboratory analysis is addressed in the applicable laboratory's standard operating procedures. Laboratory custody procedures will ensure that sample integrity and identification are maintained throughout the analytical process. Storage of samples at the laboratory will be consistent with laboratory instructions prepared by the Sample Management and Reporting organization.

A2.4 Analytical Methods

Information on analytical methods is provided in Tables A-2 and A-3. These analytical methods are controlled in accordance with the laboratory's QA plan and the requirements of this QAPjP. The primary contractor participates in oversight of offsite analytical laboratories to qualify the laboratories for performing Hanford Site analytical work.

Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Continuing Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Metals Analyzed by ICP Method – Unfiltered			
Calcium	P, HNO_3 to pH <2	SW-846[d] Method 6010B/C, SW-846 Method 6020[e], or EPA/600 Method 200.8[e]	1,000
Chromium			10
Sodium			500

Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Continuing Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Potassium			4,000
Magnesium			750
Trace Metals – Unfiltered			
Hexavalent chromium	G/P, cool to 4°C	SW-846 Method 7196	10
Anions by IC			
Chloride	P	EPA/600 Method 300.0[f]	200
Fluoride			500
Nitrate			250
Sulfate			500
Other			
Alkalinity	G/P	Standard Method[g] 2320, EPA/600 Method 310.1 EPA/600 Method 310.2	5,000
Conductivity, field	Field measurement	Instrument/meter	1 µohm
Dissolved oxygen, field	Field measurement	Instrument/meter	0 mg/L
pH, field measurement	Field measurement	Instrument/meter	0.1
Temperature	Field measurement	Instrument/meter	--
Turbidity, field measurement	Field measurement	Instrument/meter	0.1 NTU

a. All samples will be collected in plastic (P) or glass (G) containers and will be cooled to 4°C upon collection.

b. Constituents grouped together are analyzed by the same method, unless otherwise indicated.

c. Detection limit units, unless otherwise indicated.

d. SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

e. SW-846 Method 6010 is the preferred method; however, Method 6020 or EPA/600 Method 200.8 may be used, as long as the method quantitation limit listed is met.

f. Analytical method adapted from Method 300.0 (EPA-600/4-84-017, *Test Methods for Determination of Inorganic Anions in Water by Ion Chromatography*).

g. *Standard Methods for the Examination of Water and Wastewater* (AWWA et al., 2005).

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Metals Analyzed by ICP Method — Unfiltered/Filtered			
Barium	P, HNO_3 to pH <2	SW-845[d] Method 6010B/C SW-846 Method 6020[e] or EPA/600 Method 200.8[f]	20
Beryllium			5
Cadmium			5
Chromium			10
Cobalt			20
Copper			10
Nickel			40
Silver			10
Vanadium			25
Zinc			10
Trace Metals – Unfiltered/Filtered			
Antimony	P, HNO_3 to pH <2	SW-846 Method 6020 or EPA/600 Method 200.8	6
Arsenic			10
Lead			5
Selenium			10
Thallium			5
Trace Metals – Unfiltered/Filtered			
Mercury	G, HNO_3 to pH <2	SW-846 Method 7470A, EPA/600 Method 200.8	0.5
Volatiles by GC/MS			
1,1-Dichloroethene	G, no headspace	SW-846 Method 8260B	10
1,1,1-Trichloroethane			5
1,1,2,2-Tetrachloroethane			5
1,1,2-Trichloroethane			5
1,2-Dichloroethane			5
2-Butanone (methyl ethyl ketone)			10

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
2-Propanone (acetone)			20
4-Methyl-2-petanone (MIBK)			10
Benzene			5
Carbon disulfide			5
Carbon tetrachloride			5
Chlorobenzene			5
Chloroform			5
Ethylbenzene			5
Isobutanol			500
Methylene chloride			5
Tetrachloroethene			5
Toluene			5
trans-1,3-Dichloropropene			5
Trichloroethene			5
Trichlorofluoromethane			10
Vinyl chloride (chloroethene)			10
Xylenes			10
Semivolatiles by GC/MS			
1,2-Dichlorobenzene (o-Dichlorobenzene)	Amber glass	SW-846 Method 8270D	10
1,2,4-Trichlorobenzene			10
2-Chlorophenol			10
2-Methylphenol (o-cresol)			10
2-Nitrophenol (o-Nitrophenol)			20
2,4-Dinitrotoluene			10
2,4,5-Trichlorophenol			10
2,4,6-Trichlorophenol			10

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
3-Methylphenol (m-cresol)			20
4-Chloro-3-methylphenol (p-Chloro-m-cresol)			10
4-Methylphenol (p-cresol)			10
Acenaphthene			10
Butylbenzylphthalate			10
Di-n-butylphthalate			10
Di-n-octylphthalate			10
Fluoranthene			10
Hexachlorobutadiene			10
Hexachloroethane			10
n-Nitroso-di-n-propylamine			10
n-Nitrosomorpholine			10
Naphthalene			10
Nitrobenzene			10
Pyrene			10
Pyridine			20
PCBs			
Aroclor 1016	G	SW-846 Method 8082	0.5
Aroclor 1221			0.5
Aroclor 1232			0.5
Aroclor 1242			0.5
Aroclor 1248			0.5
Aroclor 1254			0.5
Aroclor 1260			0.5

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Other			
Cyanide	P, NaOH to pH >12	SW-846 Method 9012 Standard Method[f] 4500 EPA/600 Method 335.2	5
Sulfide	G/P, 2 mL, 2N zinc acetate and NaOH pH >9, cool 4°C	Sulfides – 9030	500

a. All samples will be collected in glass (G) or plastic (P) containers and samples will be cooled to 4°C upon collection.

b. Constituents grouped together are analyzed by the same method, unless otherwise indicated.

c. Detection limit units.

d. SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

e. SW-846 Method 6010 is the preferred method; however, Method 6020 or EPA/600 Method 200.8 may be used, as long as the method quantitation limit listed is met.

f. *Standard Methods for the Examination of Water and Wastewater* (AWWA et al., 2005).

Laboratories providing analytical services in support of this QAPjP will report errors to the Sample Management and Reporting project coordinator, who will then initiate a sample disposition record. The error-reporting process is intended to document analytical errors and the resolution of those errors with the project scientist. The corrective action program addresses the following:

- Evaluation of impacts of laboratory QC failures on data quality
- Root-cause analysis of QC failures
- Evaluation of recurring conditions that are adverse to quality
- Trend analysis of quality-affecting problems
- Implementation of a quality improvement process
- Control of nonconforming materials that may affect quality

A2.5 Quality Control

The QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to field variability. Field QC for sampling will require the collection of field replicates (duplicates), trip or field blanks, and equipment blanks (EBs). Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC samples are summarized in Table A-4.

A2.5.1 Field Quality Control Samples

Field QC samples will be collected to evaluate the potential for cross-contamination and field sampling performance. The QC samples and the required frequency for collection are described in this section.

Table A-4. Quality Control Samples

Sample Type	Primary Characteristics Evaluated	Frequency
Field QC		
Full trip blank (FTB)	Contamination from containers or transportation	One per 20 well trips
Field transfer blank (FXR)	Contamination from sampling site	One each day; VOCs sampled
Equipment blank (EB)	Contamination from non-dedicated equipment	As needed[a]
Replicate/duplicate sample	Reproducibility	One per 20 well trips
Laboratory QC		
Method blank (MB)	Laboratory contamination	One per batch
Laboratory duplicate	Laboratory reproducibility	See footnote b
Matrix spike (MS)	Matrix effect and laboratory accuracy	See footnote b
Matrix spike duplicate (MSD)	Laboratory reproducibility/accuracy	See footnote b
Surrogate (SUR)	Recovery/yield	See footnote b
Laboratory control sample (LCS)	Method accuracy	One per batch

a. For portable Grundfos® (registered trademark of Grundfos Pumps Corporation, Colorado Springs, Colorado) pumps, EBs are collected one per 10 well trips. Whenever a new type of non-dedicated equipment is used, an EB shall be collected every time sampling occurs until it can be shown that less frequent collection of EBs is adequate to monitor the decontamination procedure for the non-dedicated equipment.

b. As defined in the laboratory contract or quality assurance plan, and/or analysis procedures.

Full trip blanks (FTBs) are prepared by the sampling team prior to traveling to the sampling site. The FTB is filled with high-purity reagent water. The bottles are sealed and transported, unopened, to the field in the same storage containers used for samples collected that day. Collected FTBs are analyzed for the same constituents as the samples. The FTBs are used to evaluate potential contamination of the samples due to the sample bottles, preservative, handling, storage, or transportation.

Field transfer blanks (FXRs) are preserved volatile organic analysis sample bottles that are filled at the sample collection site with high-purity reagent water that has been transported to the field. After collection, FXR bottles are sealed and placed in the same storage containers with the samples from the associated sampling event. The FXR samples are analyzed for volatile organic compounds (VOCs) only. The FXRs are used to evaluate potential contamination caused by conditions in the field.

The EBs are samples in which high-purity reagent water is passed through the pump or placed in contact with the sampling surfaces of the equipment to collect blank samples identical to the sample set that will be collected. The EB bottles are placed in the same storage containers with the samples from the associated sampling event. The EB samples are analyzed for the same constituents as the samples from the associated sampling event. The EBs are used to evaluate the effectiveness of the cleaning process to ensure that samples are not cross-contaminated from previous sampling events.

For the field blanks (i.e., FTBs, FXRs, and EBs), results above two times the method detection limit (MDL) are identified as suspected contamination. However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the limit is five times the MDL.

Field duplicates, also known as replicates, are two samples that are collected as close as possible to the same time and same location, and they are intended to be identical. Field duplicates are stored and transported together and are analyzed for the same constituents. The field duplicates are used to determine precision for both sampling and laboratory measurements. The results of the field duplicates must have precision within 20 percent, as measured by the relative percent difference (RPD). Only field duplicates with at least one result greater than five times the MDL or minimum detectable activity (MDA) are evaluated.

Double-blind samples contain a concentration of analyte known to the supplier but unknown to the analyzing laboratory. The laboratory is not informed that the samples are QC samples. The project submits double-blind samples to assess analytical precision and accuracy.

A2.5.2 Laboratory Quality Control Samples

The laboratory QC samples (e.g., method blanks [MBs], laboratory control samples [LCSs]/blank spikes, and MSs) are defined in Chapter 1 of SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, and will be run at the frequency specified in that reference, unless superseded by agreement.

A2.5.3 Quality Control Requirements

Table A-5 lists the acceptance criteria for QC samples, and Table A-6 lists the acceptable recovery limits for the double-blind standards. These samples are prepared by spiking Hanford Site background well water with known concentrations of constituents of interest. Spiking concentrations range from the detection limit to the upper concentration limit determined for Hanford Site groundwater. Investigations shall be conducted for double-blind standards that are outside of acceptance limits. The results from these standards are used to determine the acceptability of the associated parameter data.

Holding time is the elapsed time period between sample collection and analysis. The contractor's environmental QA program plan provides a table with holding times. Exceeding the required holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Recommended holding times depend on the analytical method, as specified in SW-846 or *Methods of Chemical Analysis of Water and Wastes* (EPA/600/4-79/020). Data associated with exceeded holding times are flagged with an "H" in the HEIS database. Data that exceed the holding time shall be maintained but potentially may not be used in statistical analyses.

Table A-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Method[a]	QC Element	Acceptance Criteria	Corrective Action
General Chemical Parameters			
Alkalinity Conductivity pH	MB[b]	<MDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	DUP	≤20% RPD[c]	Data reviewed[d]
	MS[e]	75-125% recovery[c]	Flagged with "N"
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"

Table A-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Method[a]	QC Element	Acceptance Criteria	Corrective Action
Ammonia and Anions			
Anions by IC Cyanide Sulfide	MB	<MDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	DUP	≤20% RPD[c]	Data reviewed[d]
	MS	75-125% recovery[c]	Flagged with "N"
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"
Metals			
Arsenic Cadmium Chromium Lead Mercury Selenium Thallium ICP metals ICP/MS metals	MB	<CRDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	MS	75-125% recovery[c]	Flagged with "N"
	MSD	≤20% RPD[c]	Data reviewed[d]
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"
VOCs			
Volatiles by GC/MS	MB	<MDL	Flagged with "B"
	LCS	Statistically derived[g]	Data reviewed
	MS	Statistically derived[g]	Flagged with "N"
	MSD	Statistically derived[g]	Data reviewed[d]
	SUR	Statistically derived[g]	Data reviewed[d]
	EB, FTB, FXR	<2 times MDL[h]	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"

Table A-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Method[a]	QC Element	Acceptance Criteria	Corrective Action
Semi-VOCs			
PCBs by GC Phenols by GC Semivolatiles by GC/MS	MB	<2 times MDL	Flagged with "B"
	LCS	Statistically derived[g]	Data reviewed[d]
	MS	Statistically derived[g]	Flagged with "N"
	MSD	Statistically derived[g]	Data reviewed[d]
	SUR	Statistically derived[g]	Data reviewed[d]
	EB, FTB	<2 times MDL[h]	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"

a. Refer to Tables A-2 and A-3 for specific analytical methods.

b. Does not apply to pH.

c. Laboratory-determined, statistically derived control limits may also be used. Such limits are reported with the data.

d. After review, corrective actions are determined on a case-by-case basis. Corrective actions may include a laboratory recheck or flagging the data as suspect ("Y" flag) or rejected ("R" flag).

e. Applies to TOC and TOX only.

f. Applies only in cases where one or both results are greater than five times the detection limit.

g. Determined by the laboratory based on historical data. Control limits are reported with the data.

h. For common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the acceptance criteria is less than five times the MDL.

Data flags:

B, C = possible laboratory contamination (analyte was detected in the associated MB)

N = result may be biased (associated MS result was outside the acceptance limits)

Q = problem with associated field QC sample (blank and/or duplicate results were out of limits)

Table A-6. Blind Standard Constituents and Schedule

Constituents	Frequency	Accuracy (%)	Precision (% RSD)*
Fluoride	Quarterly	±25%	≤25%
Nitrate	Quarterly	±25%	≤25%
Chromium	Annually	±20%	≤25%

* If the results are less than five times the required detection limit, then the criterion is that the difference of the results of the replicates is less than the required detection limit.

Additional QC measures include laboratory audits and participation in nationally based performance evaluation studies. The contract laboratories participate in national studies such as the EPA-sanctioned Water Pollution and Water Supply Performance Evaluation studies. The Groundwater Project periodically audits the analytical laboratories to identify and solve quality problems, or to prevent such problems from occurring. Audit results are used to improve performance, and the summaries of audit results and performance evaluation studies are presented in the annual groundwater monitoring report.

Failure of QC will be determined and evaluated during the data validation and the data quality assessment process. Data will be qualified, as appropriate.

A2.6 Instrument/Equipment Testing, Inspection, and Maintenance

Measurement and testing equipment used in the field or in the laboratory that directly affects the quality of analytical data will be subject to preventive maintenance measures to minimize measurement system downtime. Laboratories and onsite measurement organizations must maintain and calibrate their equipment. Maintenance requirements (e.g., documentation of routine maintenance) will be included in the individual laboratory and the onsite organization's QA plan or operating procedures, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent with SW-846, or with auditable HASQARD and contractual requirements. Consumables, supplies, and reagents will be reviewed in accordance with SW-846 requirements and will be appropriate for their use.

A2.7 Instrument/Equipment Calibration and Frequency

Specific field equipment calibration information is provided in the environmental QA program plan. Standards used for calibration will be certified and traceable to nationally recognized performance standards. Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratory's QA plan.

A2.8 Inspection/Acceptance of Supplies and Consumables

Supplies and consumables used to support sampling and analysis activities are procured in accordance with internal work requirements and processes that describe the contractor's acquisition system and the responsibilities and interfaces necessary to ensure that items procured/acquired for contractor meet the specific technical and quality requirements. The procurement system ensures that purchased items comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users prior to use.

Supplies and consumables that are procured by the analytical laboratories are procured, checked, and used in accordance with the laboratory's QA plan.

A2.9 Non-Direct Measurements

Non-direct measurements include data obtained from sources such as computer databases, programs, literature files, and historical databases. If evaluation includes data from historical sources, whenever possible such data will be validated to the same extent as the data generated as part of this effort. All data used in evaluations will be identified by source.

A2.10 Data Management

The Sample Management and Reporting organization, in coordination with the RCRA Monitoring and Reporting manager, is responsible for ensuring that analytical data are appropriately reviewed, managed, and stored in accordance with applicable programmatic requirements that govern data management procedures. Electronic data access, when appropriate, will be via a database (e.g., HEIS or a project-specific database). Where electronic data are not available, hardcopies will be provided in accordance with Section 9.6 of the *Hanford Federal Facility Agreement and Consent Order Action Plan* (Ecology et al., 1989b). The HEIS database will be identified as a data repository for the Hanford Facility Operating Record unit file.

All field activities will be recorded in the field logbook.

Laboratory errors are reported to the Sample Management and Reporting organization on a routine basis. For reported laboratory errors, a sample disposition record will be initiated in accordance with contractor procedures. This process is used to document analytical errors and to establish resolution of the errors with the RCRA Monitoring and Reporting manager. Sample disposition records become a permanent part of the analytical data package for future reference and for records management.

A3 Assessment and Oversight

The elements discussed in this section address the activities for assessing the effectiveness of project implementation and the associated QA and QC activities. The purpose of the assessment is to ensure that the QAPjP is implemented as prescribed.

A3.1 Assessments and Response Actions

The contractor management, Regulatory Compliance, Quality, and/or Health and Safety organizations may conduct random surveillances and assessments to verify compliance with the requirements outlined in this QAPjP.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with the laboratory's QA plan. The primary contractor conducts oversight of offsite analytical laboratories to qualify the laboratories for performing Hanford Site analytical work.

A3.2 Reports to Management

Reports to management on data quality issues will be made if and when these issues are identified. Issues reported by the laboratories are communicated to the Sample Management and Reporting organization, which initiates a sample disposition record in accordance with contractor procedures. This process is used to document analytical or sample issues and to establish resolution with the RCRA Monitoring and Reporting manager.

A4 Data Validation and Usability

The elements in this section address the QA activities that occur after the data collection phase of the project is completed. Implementation of these elements determines whether the data conform to the specified criteria, thus satisfying project objectives. These elements are further discussed in the contractor's environmental QA program plan.

A4.1 Data Review, Verification, and Validation

The criteria for verification may include review for completeness (e.g., all samples were analyzed as requested), use of the correct analytical method/procedure, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors. Laboratory personnel may perform data verification.

A4.2 Verification and Validation Methods

The work activities shall follow documented procedures and processes for data validation and verification, as summarized below. Validation of groundwater data consists of assessing whether the data collected and measured truly reflect aquifer conditions. Verification means assessing data accuracy, completeness, consistency, availability, and internal control practices to determine overall reliability of the data collected. Other DQOs that shall be met include proper chain-of-custody, sample handling, use of proper analytical techniques as applied for each constituent, and the quality and acceptability of the laboratory analyses conducted.

Groundwater monitoring staff perform checks on laboratory electronic data files for formatting, allowed values, data flagging (i.e., qualifiers), and completeness. Hardcopy results are verified to check for (1) completeness, (2) notes on condition of samples upon receipt by the laboratory, (3) notes on problems encountered during analysis of the samples, and (4) correct reporting of results. If data are incomplete or deficient, staff work with the laboratory to correct the problem found during the analysis.

The data validation process provides the requirements and guidance for validating groundwater data that are routinely collected. Validation is a systematic process of reviewing verified data against a set of criteria (provided in Section A2.5) to determine whether the data are acceptable for their intended use.

Results of laboratory and field QC evaluations, double-blind sample results, laboratory performance evaluation samples, and holding-time criteria are considered when determining data usability. Staff review the data to identify whether observed changes reflect changes in groundwater quality or potential data errors, and they may request data reviews of laboratory, field, or water-level data for usability purposes. The laboratory may be asked to check calculations or re-analyze the sample, or the well may be resampled. Results of the data reviews are used to flag the data appropriately in the HEIS database (e.g., "R" for reject, "Y" for suspect, or "G" for good) and/or to add comments.

A4.3 Reconciliation with User Requirements

The data quality assessment process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet project DQOs. The RCRA Monitoring and Reporting manager is responsible for determining if data quality assessment is necessary and for ensuring that, if required, one is performed. The results of the data quality assessment will be used in interpreting the data and determining if the objectives of this activity have been met.

A5 References

10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements," *Code of Federal Regulations*. Available at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&rgn=div6&view=text&node=10:4.0.2.5.26.1&idno=10.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_10/40cfr265_10.html.

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